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Underground Technology Program Test Adit Construction

James B. Beck C. Richard Linamen Lachel and Associates, Inc. P.O. Box 10652 McLean, VA 22102-9652

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Technical Report

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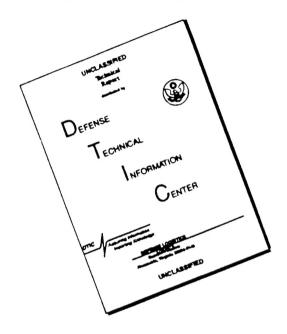
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SUMMARY

This report describes the geotechnical investigation, design, and construction of a test adit which was built to support the Defense Nuclear Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.

The geotechnical investigation includes preconstruction geologic exploration, geologic mapping, gas detection, and soil and rock hydrology. The information provided is also the result of onsite inspection, quality control review, and instrumentation of ground support areas, all performed during the course of construction.

The contractor's methods of construction are also examined, as are the remedial methods taken when methane gas was encountered during the course of construction.

PREFACE

This report documents work performed as part of the DNA Underground Technology Program, and was funded under contract DNA001-92-C-0051. The DNA Project Managers were Major Curt Krieser and Paul Senseny. The Army Corps of Engineers, Louisville District, inspectors were Mr. Tony Hamblin and Mr. Steve Duncan. The Waterways Experiment Station (WES) Site Manager was Mr. David Ward.

For Lachel and Associates: Mr. James E. Beck was in charge of overall project management; Mr. Lawrence Eckert and Mr. Ghailan Alsayab provided the geologic and tunnel engine-ring field work; Mr. Dennis Lachel and Mr. Rich Linamen provided the off-site tunnel engineering support; and Mr. Gunnar J. Radel reviewed and edited the final report.

Detailed information on the preconstruction geologic explorations and investigations can be found in Volumes 2 and 3 of the "Solicitation for Underground Technology Program, Test Adit Construction, 1992" which contains the Geotechnical Design Summary Report prepared by Lachel and Associates.

CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY	BY	TO GET
TO GET ←	BY ←	DIVIDE

angstrom	1.000 000 X E -10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn -	1.000 000 X E -28	meter ² (m ²)
British thermal unit (thermochemical)	1.054 350 X E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm ²)	4.184 000 X E -2	mega joule/m ² (MJ/m ²)
curie	3.700 000 X E +1	≋giga becquerel (G8q)
degree (angle)	1.745 329 X E -2	radian (rad)
degree Fahrenheit	$t_k = (t^0 f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.6U2 19 X E -19	joule (J)
erg	1.000'000 X E -7	jcule (J)
erg/secಾನ	1.000 000 X E -7	watt (H)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	meter ³ (m ³)
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)
kip/inch ² (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktap	1.000 000 X E +2	newton-second/m ² (N-s/m ²)
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (1bs avoirdupois)	4.448 222	newton (N)
pound-force Inch	1.129 848 X E -1	newton-meter (N°m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/foot ²	4.788 026 X E -2	kilo pascal (kPa)
pound-force/inch ² (ps1)	6.894 757	kilo pascal (kPa)
pound-mass (1bm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-foot ² (moment of inertia)	4.214 011 X E -2	kilogr am mete r ² (kg [*] m ²)
pound-mass/foot ³	1.601 846 X E +1	kilogram/meter ³ (kg/m ³)
rad (radiation dose absorbed)	1.000 000 X E -2	SGray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -8	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (sm Hg, C ^o C)	1.333 22 X E -1	kilo pascal (kPa)
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[&]quot;The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s. "The Gray (GY) is the SI unit of absorbed radiation.

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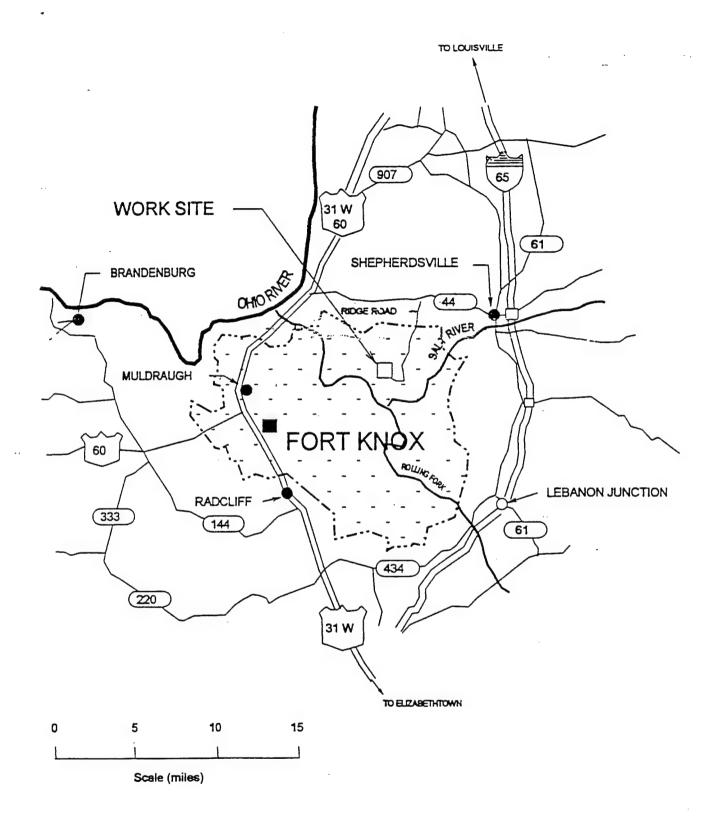


Figure 1-1. Location Map.

SECTION 1

INTRODUCTION

1.1 UNDERGROUND TECHNOLOGY PROGRAM.

The Underground Technology Program (UTP) is a part of the Government's continuing research to evaluate the lethality effects of dynamic loads on underground structures, and to develop a high-confidence method for predicting these effects. This method is being developed through both theoretical and analytical activities, combined with field tests and experimental activities. This research is sponsored by the Defense Nuclear Agency (DNA).

1.2 TEST ADIT CONSTRUCTION.

As part of the overall Underground Technology Program, DNA is developing an underground high explosive test bed at the Rodgers Hollow Area, Fort Knox, Kentucky, to support field tests and experimental activities. The test adit construction contract is the first phase in developing the test bed. Rodgers Hollow is located on the Fort Knox Military Reservation approximately 7.4 miles west-southwest of Shepherdsville, Kentucky, in Bullitt County. The Rodgers Hollow geographic coordinates are 37° 56′ 57.40308" North and 85° 50′ 34.56814" West at an elevation approximately 490 feet above mean sea level (MSL). The site location plan is shown in Figure 1-1.

The test adit was constructed by W. L. Hailey and Company, Inc. of Nashville, Tennessee under U.S. Army Corps of Engineers contract DACA27-92-R-0003 administered by the U.S. Army Corps of Engineers, Louisville District. LACHEL and Associates, Inc. of Golden, Colorado performed the tunnel design, prepared the contract drawings and specifications, and provided onsite geotechnical assistance during the construction period. The U.S. Army Corps of Engineers Waterways Experimental Station (WES) provided overall program management for the UTP and site management of the Rodgers Hollow test site.

1.3 REPORT ORGANIZATION.

This report is divided into six sections and appendices. This introduction (Section 1) is followed by a description of the test adit construction project (Section 2) and changes to the original adit design. Section 3 describes the geology and hydrology of the Rodgers Hollow site. Section 4 describes construction methods and

production rates. Section 5 describes the tunnel instrumentation, and Section 6 is a list of references. The Appendices A through D contain the geologic core logs, rock test results, geologic maps, and photographs, respectively.

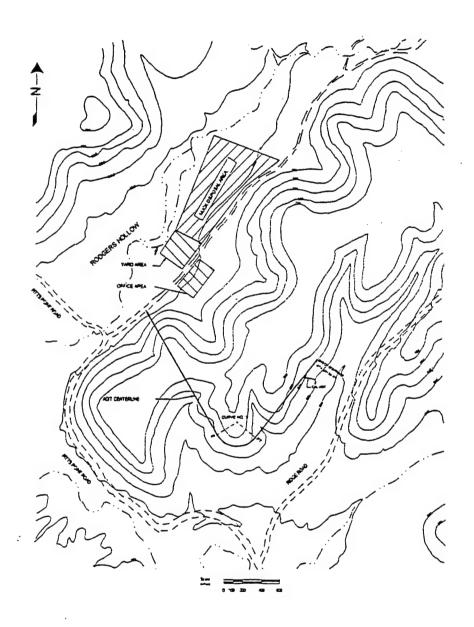


Figure 2-1. Project Site Plan.

SECTION 2

PROJECT DESCRIPTION

2.1 GENERAL.

The UTP Test Adit Construction contract was designed to provide access to the test bed located in the Louisville Formation, approximately 300 feet below the floor of Rodgers Hollow. The major items of work required by the contract included surface site work, one flood protection structure, 36 feet of cut-and-cover portal structure, 3,035 feet of 12 foot by 12 foot adit, 100 feet of 8 foot by 8 foot adit, four enlargements in tunnel cross section, and electrical, ventilation and dewatering systems.

A Request for Proposals (RFP) was issued in May, 1992, which required the submission of a two-part proposal, Technical and Cost, in separate envelopes. The cost proposal was a firm fixed price based on contractor developed unit prices for a schedule of bid items included in the RFP. The proposals were evaluated first on technical merit, and then on cost. A total of ten proposals were received in June, 1992, ranging in value from a low of \$3.8 million to a high of \$8.0 million. After evaluating the Technical Proposals, establishing a competitive range, and determining the most advantageous proposal to the Government, a contract was awarded to W. L. Hailey & Co., Inc. in July 1992, for an approximate value of \$4,665,000.

2.2 AS-BID PROJECT CONFIGURATION.

2.2.1 Site Work.

As part of the test adit construction, the contractor was required to provide and upgrade surface site facilities. Included in this item are the upgrading of the gravel road in Rodgers Hollow, providing office trailers, parking areas, contractor's laydown areas, clearing and grubbing for the portal, muck disposal, the installation of sediment control tanks, and 6,800 feet of surface discharge water line. Figure 2-1 shows the original site layout. Also included in this item of work was the providing of normal site services and maintenance such as furnishing potable water, sewage disposal, trash removal, guard service, the cleaning of offices and yard areas, and the supply and distribution of electrical power on surface.

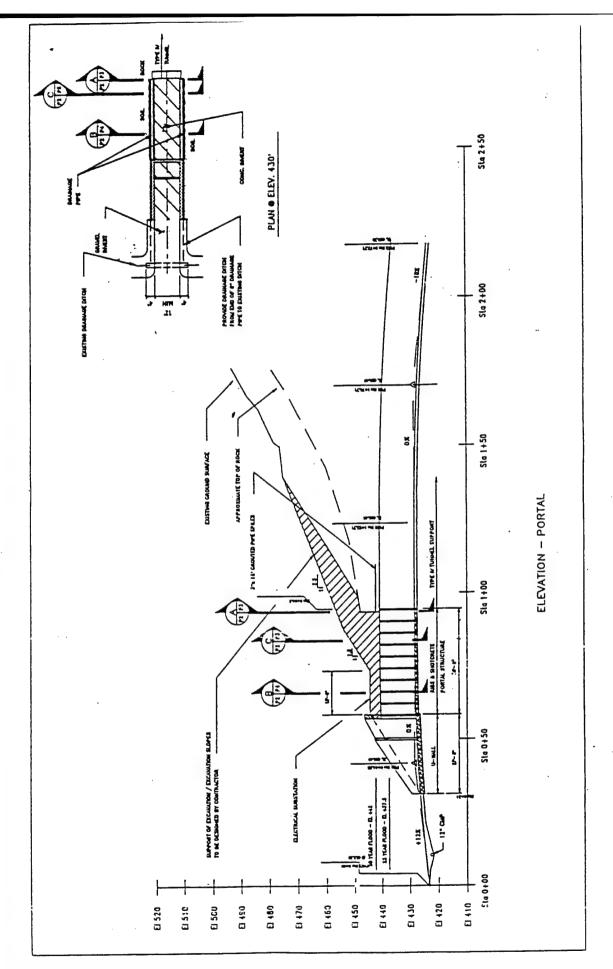


Figure 2-2. Portal Construction.

2.2.2 Portal Structures .

The portal to the test adit is comprised of two sections, a flood protection structure, and a cut-and-cover tunnel section, as shown in Figure 2-2 opposite. The flood protection structure, from Station 0+31 to Station 0+58, is a U-shaped reinforced concrete structure with removable timber stop logs (shown on Figure 2-3 on the next page). During normal operation of the site, the stop logs are removed and the structure provides unimpeded access to the portal. During flood events of the Salt River basin, the stop logs are installed in the cast-in-place guides, and an temporary earth dike is constructed in front of the stop logs to provide flood protection for the tunnel adit for a 50 year flood. When the stop logs are in place, access to the tunnel for both men and tunnel utilities is provided via the open area between the stop logs and the concrete portal at Station 0+58.

The cut-and-cover portal structure, from Station 0+58 to Station 0+94, consists of a 6 inch thick wire reinforced shotcrete with horseshoe shaped, steel arch sections (W6x25s) 4 feet on center and a 1 foot thick reinforced concrete slab at the tunnel invert. The outside of the structure is coated with an asphaltic dampproofing. A 6 inch perforated drain pipe is provided at the base of the wall on either side to prevent surface water from entering the tunnel. Figure 2-4, which follows, provides details of the structure. The portal was constructed in an open cut in the side of the hill and backfilled with structural material prior to commencing tunneling operations.

2.2.3. MAIN ADIT.

The main adit consists of 2,935 feet of 12 foot wide by 13 foot high, straight legged, horseshoe-shaped tunnel which commences at Station 0+94 and progresses downgrade on a 10 per cent slope to Station 30+29. It penetrates completely through the New Providence and New Albany Shales and terminates in the middle of the Louisville Formation, 286 feet below the portal elevation and approximately 458 feet below the top of the hill (see Figure 2-5 on page 9). The main adit alignment consists of two tangent sections, at bearings S31°06'53"E and N39°18'46"E, and a 250 foot radius curve.

A total of four widened areas or bays were required to be excavated within the main adit. The tunnel width increased to 17 feet in the bay areas to accommodate permanent electrical and mechanical equipment. Two of these bays were for electrical transformers and circuit panels, which are located at Station 15+00 and Station 29+73, and offset to the right of tunnel centerline. The other two bays contain dewatering sump boxes and pumps and are located at Station 14+56 and Station 30+17, and are offset to the left of the

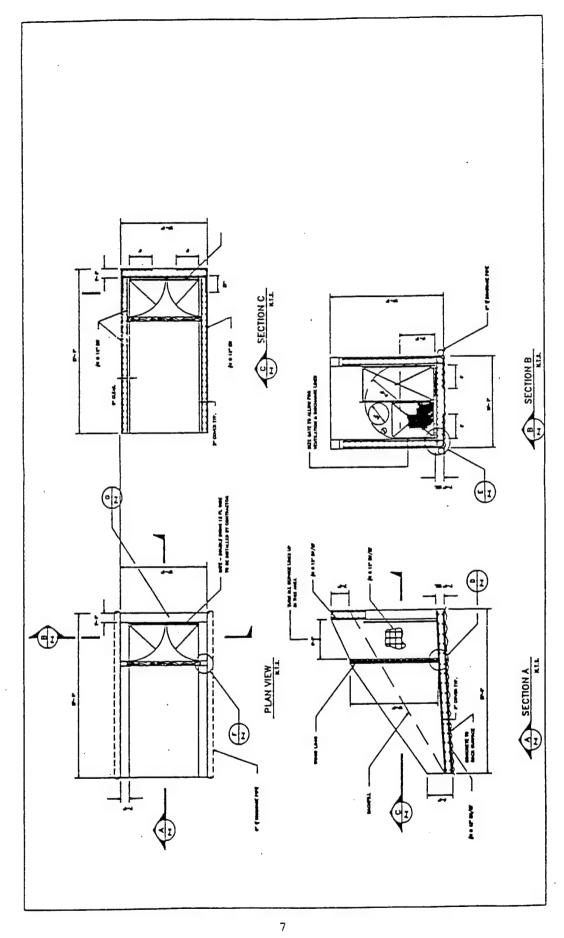


Figure 2-3. Portal U-Wall.

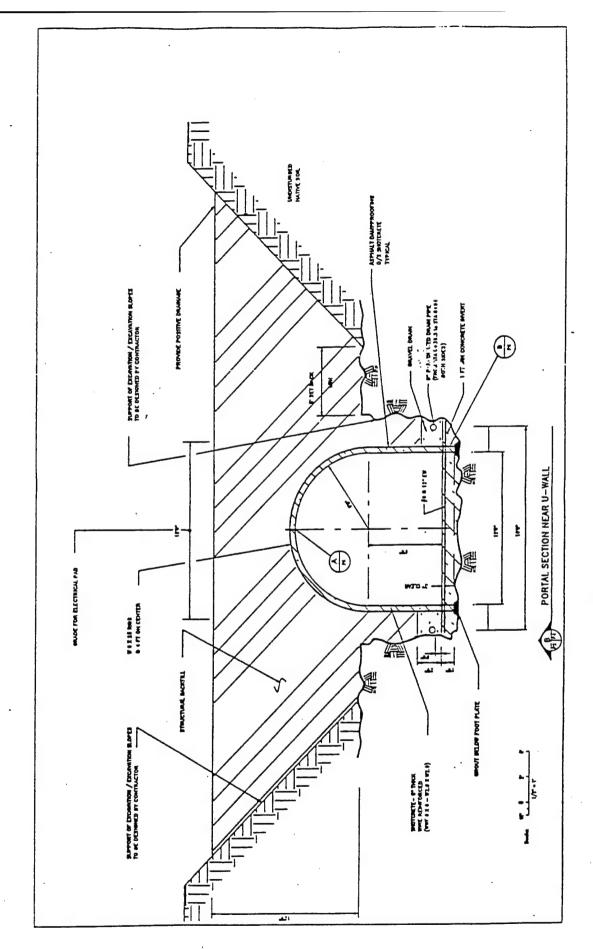


Figure 2-4. Portal Section.

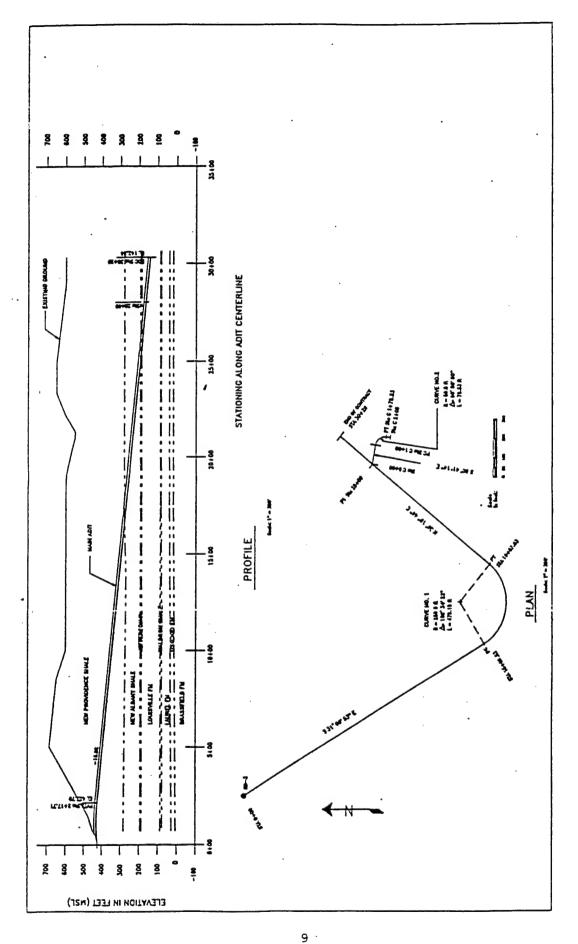


Figure .2-5. As-Bid Plan & Profile.

tunnel centerline. The design configuration of the main adit included a 12 inch thick gravel invert and a permanent lining of 2 inches of shotcrete in the shale formations, and chain link fabric in the top 120° of the crown in the limestone formations.

2.2.4 Calibration Adit and Drift.

The calibration adit forms a Y-intersection with the main adit at Station 28+00 and progresses on a S80°41′14″E bearing away from the main adit. This adit is a 12 foot wide by 13 foot high tunnel similar in cross section and configuration to the main adit and extends from Station C 0+00 to C 1+00. At Station C 1+00, the cross section reduces to an 8 foot wide by 8 foot high drift which continues to the termination of the drift at Station C 2+00. The drift is not lined with shotcrete or chain link fabric, nor does it have a gravel invert.

2.2.5 Ground Support .

The design of the permanent tunnel support was based on data obtained through the geotechnical explorations conducted at the site as detailed in Section II of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) included in Vol. 2 of the "Solicitation for the Underground Technology Program Test Adit Construction", and summarized in Section 3 of this report. The primary basis for the design of tunnel support was the Norwegian Geotechnical Institute (NGI) Q-system which is a quantitative design method based on the evaluation of hundreds of tunnels. The method considers a variety of parameters that are known to affect tunnel stability.

The initial ground support calculations, based on the data obtained during the geotechnical investigation, indicated that the formations to be excavated (the New Providence Shale, the New Albany Shale, and the Louisville Carbonate) required only minimal support, for example, spot bolting in localized areas. However, it is recognized that even the best geotechnical investigation can only identify those features which are intersected by the borings, and that subsurface conditions between borings may vary considerably. Therefore, it was decided to provide four tunnel support designs in the contract to accommodate the likely variations in ground conditions which might be encountered during construction. As the tunnel was excavated, the actual ground conditions encountered were evaluated by a geotechnical engineer familiar with the design requirements, and the most appropriate tunnel support design was selected for each region. This approach allows the contractor the greatest flexibility in constructing the tunnel while affording the owner the lowest cost alternative based on the actual conditions encountered.

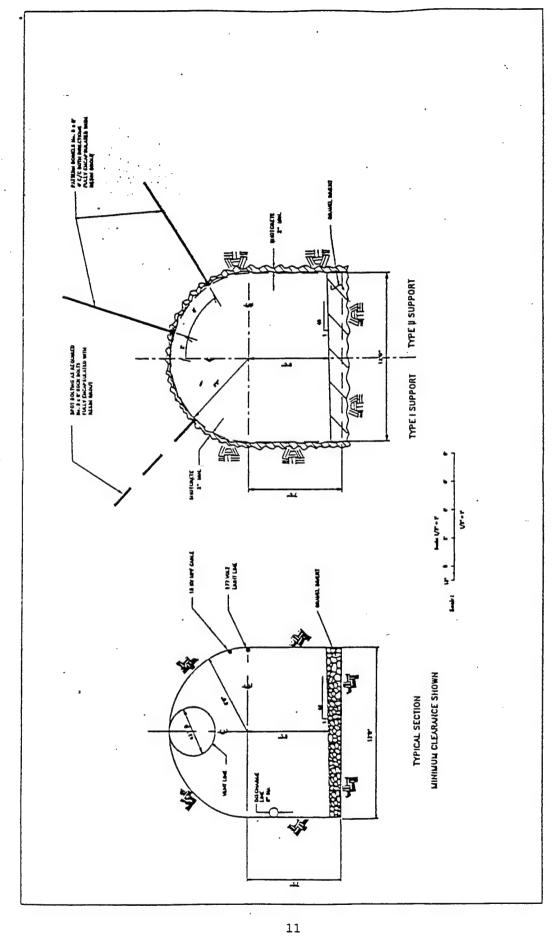


Figure 2-6. Tunnel Supports.

In determining the permanent ground support requirements, the rock geotechnical mass characteristics developed during the investigation were the primary factors considered in the design. However, additional factors such as extent of weathering, proximity to the surface, material durability, and dynamic loading from the future test events were also considered in determining the final Based on the evaluation of rock mass support requirements. characteristics and future use of the site, four types of tunnel support were selected for use in the contract. The support methods included: Type I Support, spot rock bolts (Number 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type II Support, pattern rock dowels (No. 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type III Support, pattern rock dowels (No. 8 by 8 foot long at 4 foot on center) with chain link fabric in the top 120° of crown; and Type IV Support, W6x25 steel sets at 4 foot center-to-center spacing. While the exact locations for each type of support were not determined at the time of bid, the contract provided an estimate of the quantity of each type for bidding purposes. These ground support methods are depicted in Figure 2-6, (Type I and II) and Figure 2-7 on the following page, (Type III and IV).

In addition to the main adit support designs detailed above, permanent ground support designs for the two transformer bays, two sump bays and the Calibration Adit intersection were specified in the contract. This consisted of pattern rock bolts (No. 8 by 10-foot long 4 foot on center) and a 2 inch thickness of non-reinforced shotcrete for the four bays, and a 4 inch thickness of wire reinforced shotcrete for the Calibration Adit intersection.

In the shale formations, the anticipated primary failure mode was the deterioration of the rock surface due to moisture loss, commonly referred to as air slaking, which causes the rock to ravel (disintegrate into pieces). To prevent this deterioration, a 2 inch minimum thickness of shotcrete was specified throughout the shale formations, and it was necessary to seal the shale with shotcrete within 24 hours of exposure to the atmosphere. In order to facilitate the tunnel advance and reduce the cost of the project, the specifications allowed the shale to be covered with a air-excluding sealant within the first 24 hours of exposure to temporarily protect the rock surface from deterioration or air slaking. The permanent shotcrete lining was then applied some distance behind the advancing face, effectively removing it from the daily mining cycle and allowing the contractor to utilize a separate and more efficient operation.

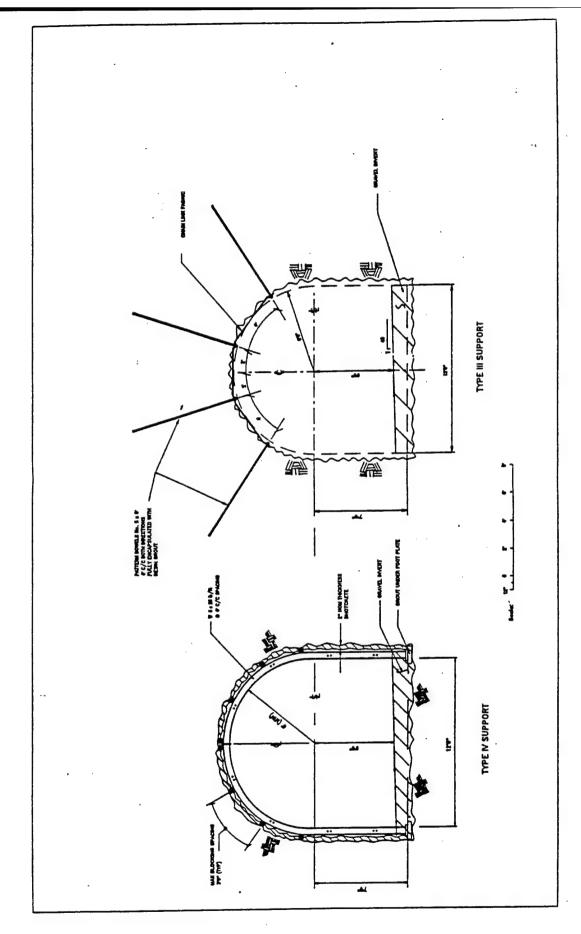


Figure 2-7. Tunnel Supports.

2.2.6. Electrical and Mechanical Systems.

The contract included a permanent electrical power distribution and lighting system for both the surface and underground work areas. This system included the 1,000 kVA main substation located above the adit portal. The system also included transformers and distribution systems for the contractor's yard area and the tunnel services. The tunnel system consisted of three substations each comprised of a transformer and power distribution panels. One substation was located together with the main substation on surface, and the other two substations were installed in enlargements in the main adit at Station 15+00 and Station 29+73.

The permanent mechanical systems included a tunnel ventilation system, and a dewatering collection and discharge system. The tunnel ventilation system included two 42-inch diameter, 75 horsepower axial vane fans and approximately 3,100 linear feet of 42 inch diameter steel vent line. The dewatering system included: four 2,800 gallon sumps, two located at the portal, and two located in the tunnel at Stations 14+56 and 30+17; six submersible pumps, and approximately 3,100 linear feet of 6 inch diameter steel discharge line.

2.3 CHANGES DURING CONSTRUCTION .

While there were a number of minor changes during the course of the contract, there were only four substantial changes which affected the final configuration of the project. Of these four significant changes, two were contractor initiated, one was Owner initiated, and one was due to differing site conditions.

2.3.1 Contractor Initiated Changes.

The first contractor initiated change dealt with the 6 inch discharge line from the adit portal to the Salt River. The contract required that a 6 inch spiral weld steel pipe with Victaulic couplings be installed on the ground surface from the portal to a discharge point in the Salt River, which the contractor was required to maintain during the life of the contract. The contractor proposed changing this to a buried 6 inch PVC pipe in place of the above ground steel pipe. While the installation cost to bury the line was higher than the above ground installation cost, there were savings in material and line maintenance expenditures realized for the duration of the contract, and for future contracts as well. This made the revision virtually a nocost change for the Government and it was accepted on that basis.

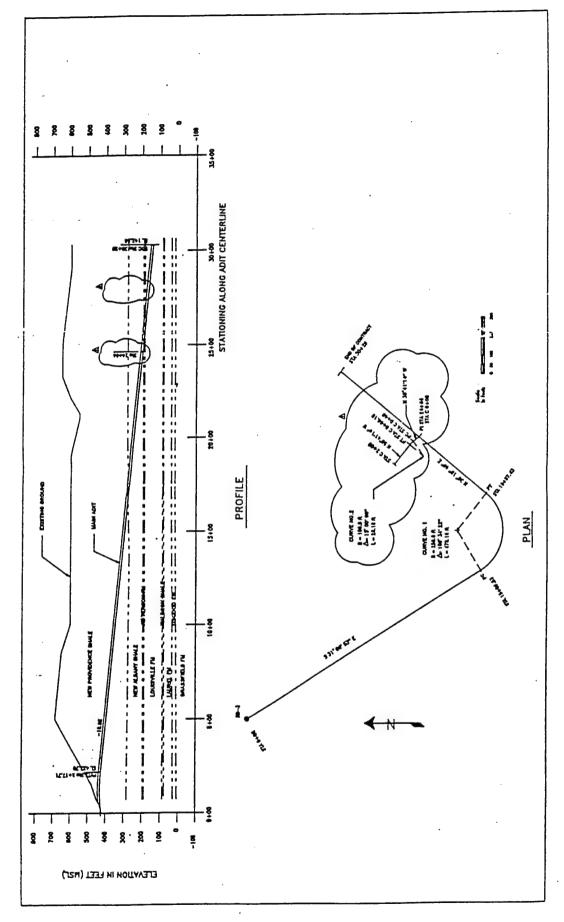


Figure 2-8. Revised Cal Adit Plan & Profile.

The second contractor initiated change involved substituting a 6 inch thick wire reinforced concrete invert in the shale formations for the 1 foot thick gravel invert specified. The contractor proposed this revision as a no-cost change, noting that the increased cost for the concrete invert would be offset by a savings in increased mining production and reduced maintenance of the tunnel invert. The change to a concrete invert in the shale formations was accepted by the Government.

2.3.2 Owner Initiated Change.

As plans for the overall test configuration for the UTP test bed were developed further, the Government found it necessary to relocate the Calibration Adit to accommodate the overall test objectives for the UTP. The Government initiated a design change which relocated the Calibration Adit from Station 28+00 with a bearing of S80°41'14"E to Station 24+64 with a bearing of N35°41'14"W. The change also eliminated the 100 feet of 8 foot by 8 foot drift and replaced it with a additional 100 feet of 12 foot by 13 foot drift and 10 feet of 10 foot diameter shaft. Figure 2-8 shows the alignment changes and Figure 2-9 on the next page depicts the Calibration Adit and Charge Shaft details.

This change was negotiated with the contractor, but it was never implemented due to the more sweeping changes in the scope of the project necessitated by the differing site condition at Station 18+54.

2.3.3 Differing Site Condition .

On June 25, 1993, when the tunnel heading was at Station 18+54, detectable levels of methane gas were encountered. The contractor immediately ceased mining operations, withdrew the roadheader from the face, and instituted a gas monitoring program to determine the extent of the gas inflow. Over the course of the next several days, the gas monitoring program indicated that while the flow of explosive gas was sporadic, varying from zero to greater than 20 percent of the Lower Explosive Limit (LEL) of methane, it was continuing, and exceeded the OSHA limits. This necessitated a change in classification of the tunnel from "non-gassy" to "gassy". The revision in tunnel classification required that the mining equipment, ventilation equipment, and electrical equipment be changed to comply with the more stringent requirements for gassy tunnels. Over the next several months, various alternate plans to continue the project were evaluated on the basis of requirements, safety compliance, constructibility, and cost and schedule impacts.

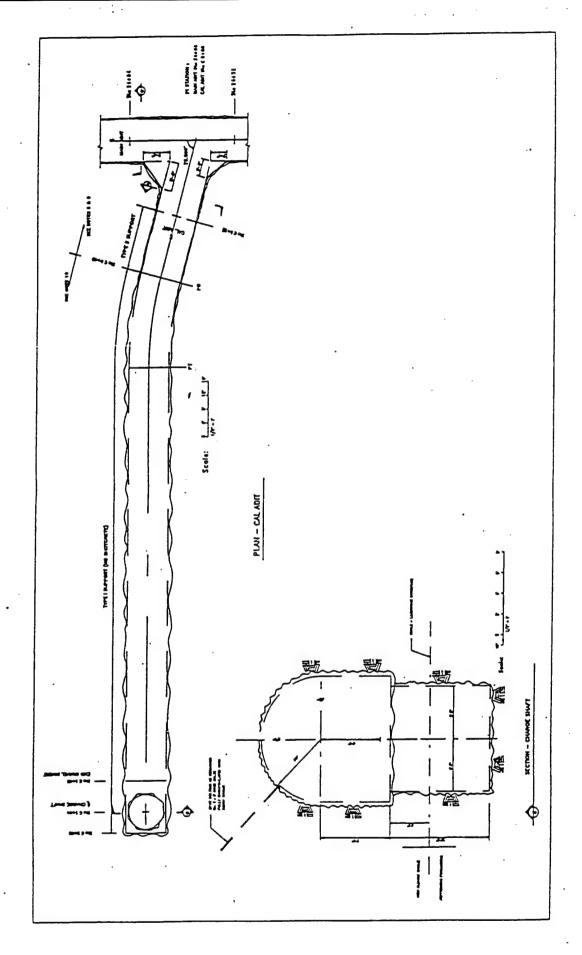


Figure 2-9. Revised Cal Adit.

A ventilation expert from the Bureau of Mines, and additional safety personnel from the DNA Field Command, Las Vegas, were brought in to assist in the development of the alternate plans for the completion of the test adit construction contract. Based on an evaluation of the alternate plans available, and an extensive review of the overall UTP requirements, DNA directed that the adit construction be terminated at Station 18+54. DNA also directed that the gas producing portion of the tunnel had to be sealed with a containment plug and pressure grouting, similar to that utilized at the Nevada Test Site (NTS), and that a 12 foot wide by 13 foot high test adit be constructed parallel to and below the existing main adit. As a result of this determination, the following changes were implemented:

- The existing ventilation system was upgraded by replacing the non-explosion-proof fan with an explosionproof fan.
- A continuous gas monitoring system with remote sensors was installed and interlocked to the tunnel lighting and mine power feed systems.
- 3. The gas inflow was isolated from the work area with concrete slab and vent pipes connected to a main vent line. Figure 2-10 on the next page shows this arrangement.
- 4. A containment plug was installed from Station 17+70 to Station 18+00 utilizing the NTS grout mix and a pressure grout containment plug (see Figure 2-10).
- 5. 524 feet of a 12 foot wide by 13 foot high test adit was constructed starting at the main adit Station 16+00 and progressed on a 0.5 percent slope up and back toward the portal on a parallel heading, 100 feet north of the main adit. Figure 2-11, which follows, provides an as-built plan and profile for this revision.
- 6. The main adit from Station 18+54 to Station 30+29 was deleted.
- 7. The electrical substation at Station 29+73 was deleted and the permanent electrical distribution in the tunnel was revised.
- 8. The dewatering sump at Station 30+17 was eliminated and the 6-inch tunnel discharge line was terminated at the dewatering sump at Station 15+00.
- The Revised Calibration Adit at Station 24+54 and charge shaft was deleted.

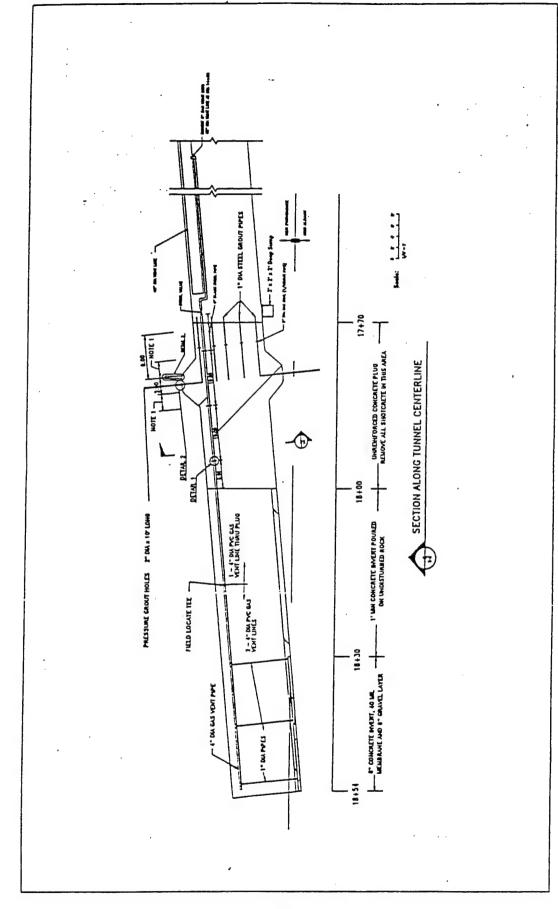


Figure 2-10. Gas Containment Plug.

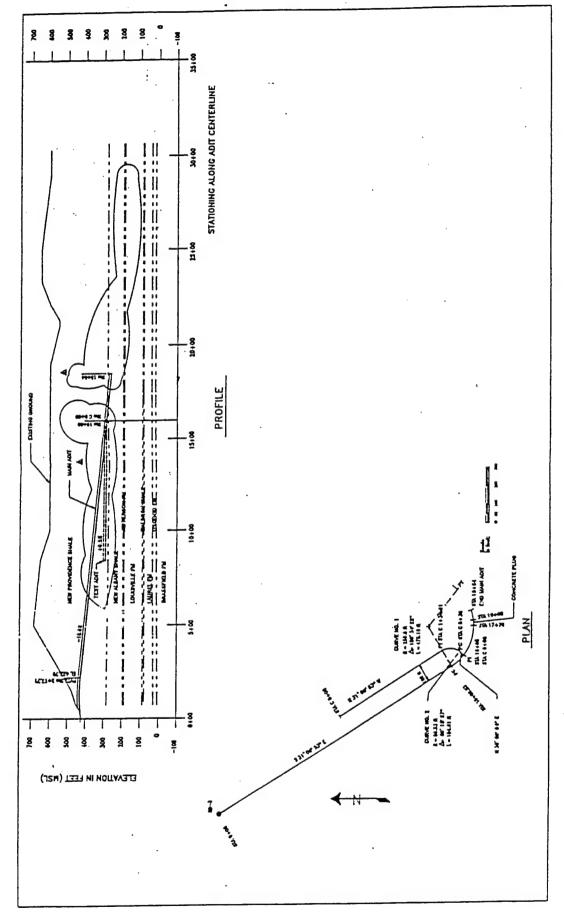


Figure 2-11. As-Built Plan & Profile.

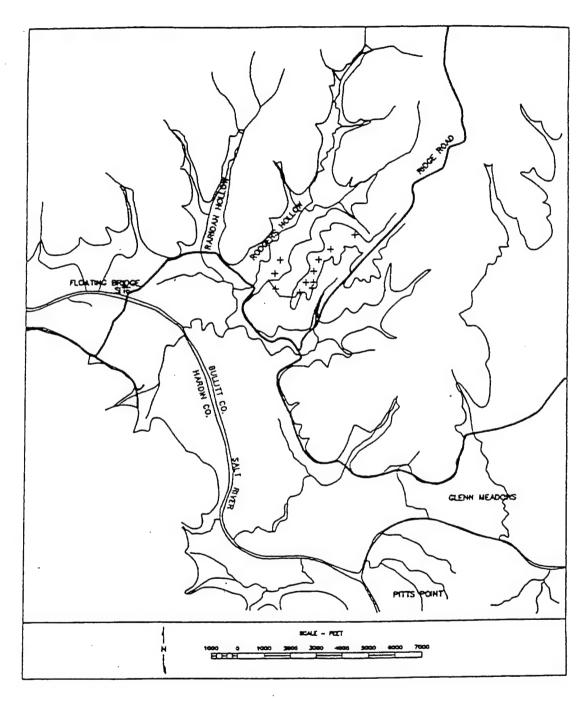


Figure 3-1. Rodgers Hollow Area.

SECTION 3

GEOLOGY

3.1 GENERAL SITE AREA .

The UTP project area lies beneath a ridgeline and immediately east of a small tributary valley to the Salt River on the northern end of Ft. Knox. A map is provided in Figure 3-1, as well as earlier in Figure 1-1. The portal for the adit was excavated on the lower hillslope of the ridgeline, just above the slope break to the valley, which is called Rodgers Hollow. The Rodgers Hollow area is characterized by a relatively flat valley floor surrounded by hills on three sides. The area is drained by a small unnamed creek that branches into two forks in the northern portion of the hollow. This creek flows into the Salt River approximately 0.6 miles southwest of the entrance of Rodgers Hollow.

The overburden material in Rodgers Hollow consists of quaternary alluvium and lacustrine deposits; generally light-tan to dark-brown silts and clays with varying amounts of sand, gravel, and rock fragments. Zones of gray to olive-gray silty clays are commonly encountered in an intermix with the brownish material. The overburden slopes toward the drainageway in the hollow and nominally parallels the ground surface contours. In many areas of Rodgers Hollow, the water table is 2 to 6 feet below the ground surface.

The bedrock at the portal elevation is shale that is a part of the Mississippian-age Borden formation. The portal was constructed at the boundary between the upper shale member of the Borden Formation, the Nancy Member, and the underlying New Providence Shale Member (see Figure 3-2 on the next page). At this site, the Nancy and New Providence Members are essentially indistinguishable, although the silt content of the Nancy Shale is known to be slightly higher than that of the finer grained, underlying New Providence Shale. The general hillslope, above the slope break to the valley, has a minimal soil profile and a weathered zone approximately 20 to 30 feet thick. Because the New Providence and Nancy Members of the Borden Formation are so impervious to water, the depth of weathering usually does not exceed 30 feet below the ground surface.

The Nancy Member Shale base lies at the portal elevation and is approximately 150 feet thick, so that under the main portion of the ridgeline, the Nancy Shale overlies the adit for a considerable thickness. The New Providence Member Shale continues 180 feet beneath the portal. Another 80 feet of shale thickness, the New Albany Shale, exists below the New Providence, making the total

SYSTEM	SERIES	GLACIATION	FORMATION, MEMBER, AND BED		THICKNESS (FT)
	HOLOCENE		YOUNGER ALLUYIU		0-20
QUATERNARY	PLEISTOCENE	ILLINOISIAN	LACUSTRINE,LOES		0-85
TERTIARY 7 & QUATERNARY	PLIOCENE 1 &	·	TERRACE DEPOSITS		0-90
			ST. LOUIS LIMESTONE		
	a _		LIBESTONE		CHET
	MERAMECIAN		SALEN		LOWER
			LIMESTONE	1	PRESIDENT
			HARROOSSURO LIMESTONE		40
PIAN					\$0 –70
MISSISSIPPIAN	OSAGEAN		MULDRAUGH MEMBER WEMBER NANCY MEMBER		160
Σ	NAPIDOHISEDIN		NEW PROVIDENCE SHALE O MEMBER		180
			NEW ALBANY		78
DEVONIAN	MIDDLE & UPPER DEVONIAN		SHALE		7-8
SILURIAN	HEACERRAN		JEFFERSONVILLE		102
]			WALDRON		
l ls			LAUREL	7	45

Figure 3-2. Strategraphic Column of Ft. Knox UTP Area of North Central Kentucky.

aggregate thickness of shale above and below the portal elevation greater than 300 feet. Beneath the New Albany are the initial test target carbonates of the Louisville Formation.

The uppermost hillslopes, just below the ridge line, are also predominantly shale, yet they actually classified as shaley siltstone with minor beds of limestones, dolometic siltstones, shales, and sandstones. The materials are of the Upper Borden Formation (Muldraugh Member). The ridge-capping materials consist of the Harrodsburg and the overlying Salem Formations. All the hillslope and ridgeline materials are of Mississippian age. The stratigraphic relationship and thicknesses of the rocks of this area of Ft. Knox are shown in the stratigraphic column on Figure 3-2 opposite.

The valleys bordering the test site ridge have been formed by erosional processes of the tributary streams; however, the valleys in the vicinity of the test site have also been affected by a major glacier advance during the Illinoisan Ice Age which occurred approximately 200,000 years ago. Glaciers advanced to within 50 miles of the site area. The advance, along with the climate effects associated with the glacial period, caused substantial erosion and alteration to the existing drainage of the area, including the rerouting of the ancestral Ohio River from a more northerly position to the one now currently occupied (Reference 1) as shown in Figure 3-3 on the next page.

The ice advance caused the pooling of water in many very large areas, including a huge temporary lake in the vicinity of Louisville, which encompassed Rodgers Hollow and the nearby valleys. This led to the deposition of some very low-strength lacustrine (lake bed) silty clay units in the valleys. The weak lacustrine deposits associated with the valleys were not a factor in the adit design and construction because they exist at elevations below the portal, and are present only within the valley boundaries.

3.2 ADIT GEOLOGY.

A geologic profile along the adit centerline is shown in Figure 3-4 which follows. The adit portal materials consist of the basal Nancy Member Shales and upper New Providence Shales of the Borden Formation. As the adit penetrates deeper, the New Providence Shale, while appearing lithologically quite consistent, has a gradual decrease in the fine-grained, granular quartz content with increasing depth. The contact with the underlying New Albany Shale is obvious, as it is where the dark gray shales of the New Providence give way abruptly to the dark brown shales of the New Albany. The New Albany is a more competent shale than the New Providence, although it is less dense because of the high

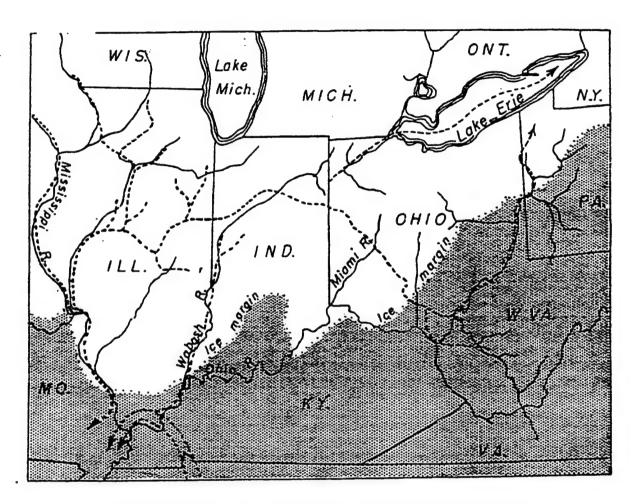


Figure 3-3. Maximum Advance of Glaciers In Ft. Knox Revion.

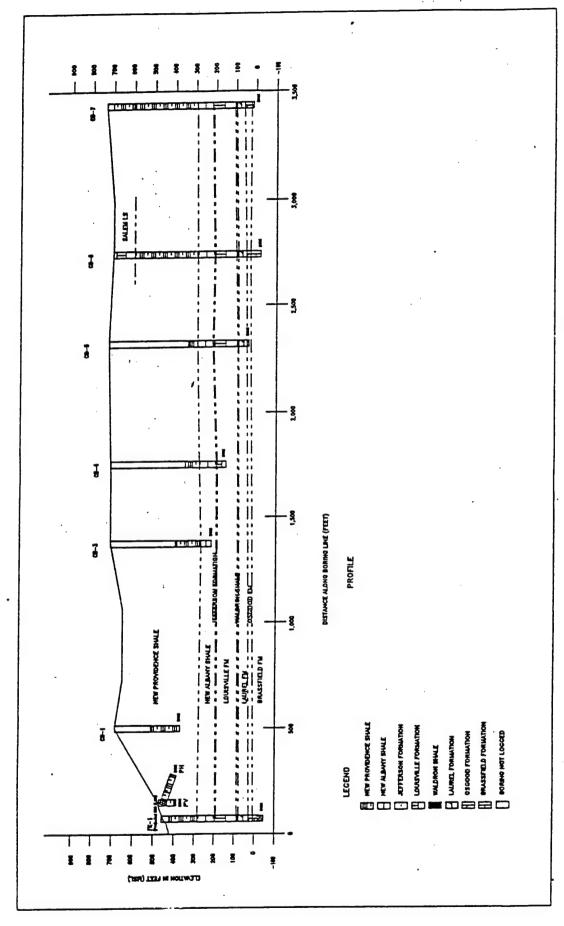


Figure 3-4. Geologic Profile Along Adit Centerline.

percentage of kerogen (organic material) it contains.

Below the New Albany there is an equally recognizable transition to the important carbonate (limestones and dolomites) section of the uppermost carbonate formation horizon. The Jeffersonville limestone which varies in thickness through the test area from 6 to 9 feet. Beneath the Jeffersonville is the 100 feet thick Louisville Carbonate Formation. The Louisville is difficult to distinguish from the overlying Jeffersonville, unless it is tested by applying hydrochloric acid. The Jeffersonville is mostly limestone (calcite (CaCO3)) while the Louisville is predominately dolomite (Ca, MgCO₃). However, there are zones within the Louisville which are rich in calcite and can be classified as limestone, hence, the term Louisville Carbonate was chosen.

Since the adit was never intended to penetrate below the Louisville Formation, the deeper formations (Laurel, Osgood, and Brassfield), which were penetrated by the exploratory borings, are not described herein.

3.3 FIELD EXPLORATION PROGRAM .

The geotechnical characterization of the UTP project site consisted of field explorations and testing. The purpose of the explorations was to provide the factual data to characterize the site for testing purposes, and to identify the geotechnical conditions expected during excavation of the portal and adit, including the geologic formations, rock type and condition, and the anticipated ground water conditions which had to be addressed. To accomplish this task, four geologic exploration techniques were used: core drilling; hydrologic testing and water sampling; geophysical logging; and formation gas detection.

The exploration activity was chronologically subdivided into four different phases. These were: 1) site-selection, 2) adit lay-out, 3) groundwater monitoring and testing, and 4) formation gas detection. Ft. Knox was only one of a number of sites considered during Phase 1, site selection, and the last of this work was accomplished during calendar year 1990. Phases 2, 3 and 4 were accomplished only for the Rodgers Hollow site, and were conducted concurrently during the calendar year 1991. Additional exploration activities classified under phases 2 and 3 were conducted during the construction of the test adit in the calendar years 1992 and 1993.

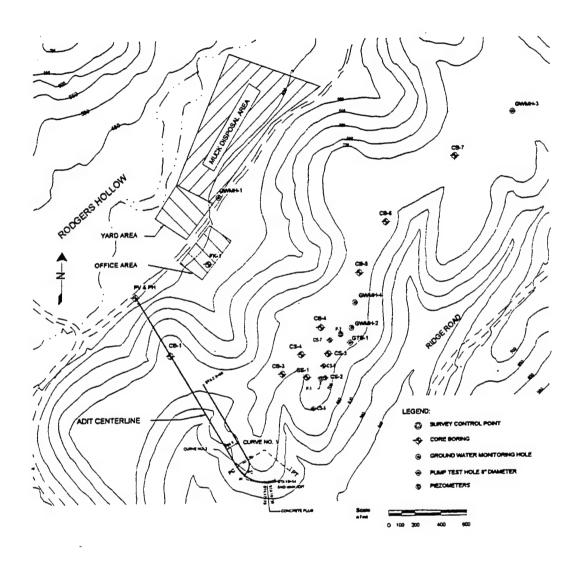


Figure 3-5. New Site Plan With All Borings Shown.

3.3.1 Core Drilling.

A total of 15 NQ and NX core borings were drilled and logged as part of the preconstruction exploratory program developed for the UTP. During the site selection (Phase 1) of this project, two borings, FK-1 and FK-2 were cored with NQ wireline equipment, each to a depth of 500 feet. This work was performed under contract for WES using a Failing 500 drill rig. Site-specific explorations (Phase 2) to lay out the adit and define the anticipated tunneling conditions included borings CB-1, CB-3, CB-4, CB-5, CB-6, and CB-7 (boring CB-2 was not drilled). Explorations conducted to define the conditions at the portal location included one vertical and one angle boring, designated PV and PH respectively. All of the Phase 2 drilling was performed by U.S. Army Corps of Engineers drill crews. Five additional borings, GWMH-1, GWMH-2, GWMH-3A, GWMH-3A, and GWMH-4 were cored as part of Phase 3 groundwater monitoring program. All of these holes were drilled by the Corps of Engineers using HQ wireline equipment. Boring GWMH-3A was logged only by the geophysical surveys, and GWMH-4 was not logged at all.

During the Test Adit Construction phase of the UTP, an additional exploratory program was carried out in December 1992, and in May 1993, in which a total of 9 additional borings were drilled and logged. Piezometers were later installed in five of these borings (P-1, P-2, CS-5, CS-6, and CS-7) and in two of the previous borings (GWMH-2 and GWMH-4). The boring locations are shown on Figure 3-5 on the opposite page and the logs of the borings are presented in Appendix A.

3.3.2 Geologic Discontinuities.

Based on data obtained from the preconstruction exploratory borings and other available geologic data available, it was concluded that no faults or shears would be encountered. It was also concluded that bedding plane joints, which are horizontal to moderately inclined, would comprise the majority of joints encountered.

Discontinuities in the New Providence Shale are typically planar, tight to moderately tight, horizontally oriented (0° to 10°) with smooth to slightly rough surfaces and with a few occurrences of soft clay fillings. The discontinuities are mostly unweathered. The New Albany Shale, on the other hand, has steeper discontinuities (0° to 40°), with occasional calcite and pyrite fillings. The joints are planar, slightly rough to rough-surfaced, moderately tight to tight, and unweathered. The Louisville Carbonate Formation typically has a higher frequency of discontinuities than both the New Providence and New Albany Shales. Discontinuities here are steeper (0° to 50°), and are open. Calcite fillings are frequent along the joints. Weathering of discontinuities in the Louisville Carbonate Formation is more

evident.

Geologic mapping of main and test adits confirmed the exploratory data obtained for the New Providence Shale. In accordance with the exploratory data, no shears or faults were encountered and only five open and bentonite-filled joints were encountered. All of these were encountered in the first 141 feet of main adit, close to portal (Station 0+94 to Station 2+34). Every one of these discontinuities were transverse and vertically oriented (252° to 263° Azimuth strike and 75° to 85° NW dip direction).

There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62. Their measured Azimuth strikes ranged from 305° to 335° except for the bedding plane at Station 17+65 which had a 285° Azimuth strike. Dip angles for these planes were 6.5° to 9° NW direction except for the plane at Station 17+65 which had a SW dip direction.

Since all of the explorations, other than portal boring PH, were drilled vertically, exploratory data would be biased against high-angle fractures, and the exploratory borings data for the New Albany Shale and the Louisville Carbonate Formation may not be representative of what might be encountered in the adit when tunneling into these strata.

3.3.3 Hydraulic Testing and Water Sampling.

The UTP site-selection criteria required that the final experimental test bed be located in a water-saturated, carbonate rock. The hydrologic properties of the Louisville Formation are important characteristics, not only for test bed predictions, but also for anticipating ground water conditions during construction. To that end, a program to establish and define the hydrologic nature of the site was developed and consisted of:

- Constant head tests using downhole packer injection to establish rates of flow and hydraulic conductivity by depth interval.
- Water sampling to determine water quality.
- 3. A long-term (25-hour) pump test to determine the ability to draw down the primary aquifer at the site (Louisville Carbonate Formation).

The injection (pump in) tests were conducted in seven of the NQ boreholes to determine the volume of water required to maintain a constant head.

Table 3-1. Summary of Aquifer Water Quality .

ANALYSIS	RESULTS
Conductivity	27,000 micro-omhs
ph	7.01
Total Alkalinity	456
Chloride	11,535 mg/l
Calcium	588 mg/l
Magnesium	336 mg/l
Sodium	5,620 mg/l
Hardness (CaCO3)	2,820 mg/l
Total Dissolved Solids	16,500 mg/l

Determining the quality of the groundwater present in the Louisville Formation was an important consideration in the planning of the UTP Test Adit Project. An uncontaminated water sample was obtained from boring CB-6 and chemically tested. The results of the laboratory test are reported in Appendix B.3 of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) and are provided in Table 3-1. Due to the high chloride content of the groundwater, it was necessary to make special provisions in the contract to pipe the tunnel discharge water to the Salt River and to specify minimum dilution factors for its discharge into the river.

The long term pump test was performed using a large diameter boring, denoted as borehole GTB-1. An 8-1/2 inch diameter hole was drilled with an air hammer to a depth of 102 feet, and a 6 inch diameter PVC pipe was set in place and sealed with Bentonite. The remainder of the hole was then drilled with a 6 inch diameter air hammer button bit to a total depth of 640 feet. Detailed results of this test were reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) Tables 3-2 and 3-3 on the following page summarize the results from the active and passive pumping phases of the pump test performed at boring GTB-1.

Based on the data obtained through the hydraulic testing program conducted at the site, it was established that the porosity in the carbonate material, known in many situations to be laterally variable, exists only on a minor scale in the immediate vicinity of the Louisville Carbonate Formation of interest. Furthermore, the Louisville Formation water reservoir could be considered isotropic in properties and in extent. The two distinct porosity zones of the Louisville Carbonate Formation, the upper and the lower porosity zone, appear to be both laterally continuous (at least in the area of the program borings), as suggested by their presence in each well of the pump test program. Also, only partial water level recovery was achieved in a 24 hour period after pumping. This suggests that the extent of the aquifer is limited.

Using the characterized coefficient of transmissibility in the vicinity of borings GTB-1 and GWMH-2 as 750 to 1120 gpd/ft (100 to 150 ft³/day/foot), as reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) and using 74 feet as the nominal aquifer thickness, the equivalent hydraulic conductivity would be 1.35 to 2.03 ft/day. Assuming a steady-state drainage for both the borehole and the adit under a constant water head of 270 ft, the tunnel was estimated to produce about 510 to 766 Ft³ of water per day per foot of length in the aquifer (see Appendix B.2). This translates to approximately 2.6 to 4.0 gpd per foot of adit. Since the adit was designed to have a 10 percent downward grade, the 74 feet of aquifer translates to approximately 740 feet of aquifer zone penetration. The resulting total flow within the Louisville

Table 3-2. Coefficients of transmissibility and storage, Active Pumping Phase GTB-1.

WELL TEST	RANGE FROM GTB-1 (FT)	COEF TRANS (T) GPD/FT	COEF STORAGE (S)
GWMH-2	121	676	3.60
GWMH-4	320	1650	1.34
CB-5	540	663	1.75
CB-6	960	539	1.90
FK-1	1250	499	1.53
GWMH-1	1520	. 580	0.92
CB-7	1590	434	0.61
GWMH-3A	2090	868	0.48

Table 3-3. Coefficients of transmissibility and storage, Passive Recovery Phase GTB-1.

WELL/TEST	COEF TRANS (T), GPD/FT
GWMH-2	729
GWMH-4	1600
CB-5	1422
CB-6	1307
FK-1	937
GWMH-1	904
CB-7	1114

aguifer was calculated to be 1,925 to 2,960 gallons per day.

3.3.4 Geophysical Surveys.

Geophysical wireline logging was conducted in each of the core borings drilled at the site in the preconstruction exploration phase, except for the portal area borings (PV and PH) and the air drilled boring (GTB-1). Various types of geophysical logs were performed during this program. All logs were run in the open hole within several months of the completion of the drilling of each hole. The types of log runs, the principle of measurement, the recorded parameters of each log type, and the results of the logging are summarized in Section V of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2).

3.3.5 Formation Gas Detection .

In an attempt to detect the possible presence of formation hydrocarbon and/or hydrogen sulfide (H_2S) gases, a "mud logging" unit was employed during the air drilling of boring GTB-1 in July, 1991, to monitor the returning air stream in order to determine the presence and concentration of either or both of the gases.

The hydrocarbon gas detection involved the use of two instruments, a total hydrocarbon gas detector, and a gas chromatograph unit. The total hydrocarbon gas detector that was utilized on the UTP logging is commonly referred to as a thermal conductivity detector (TCD). This unit provides a continuous measurement of the presence and level of total combustible gases either within the flow stream, as in the case of air drilling, or emanating out of solution from the recirculating mud stream. The gas chromatograph, uses discrete samples, separating the mixture into its component gases, and then samples each component. In this way the device can determine the type, such as methane (CH,), ethane (C2H6), propane (C_3H_8) , butane and/or isobutane (C_4H_{10}) , and pentane (C_5H_{12}) , and concentration of each component gas within. Methane (CH4) gas was The total hydrocarbon in borehole GTB-1. concentration was measured and recorded, as well as an independent methane concentration level. The results are presented in Figure 3-6 on the following page.

Figure 3-6 also shows the data recorded from the hydrocarbon gas detectors adjacent to the lithologic log and stratigraphic column. There was no gas was detected through the entire Borden Shale section of the hole. The first detection of gas corresponds with the drill bit penetration into the top of the organically rich New Albany Shale, and the sustained high readings matched almost perfectly with the interval within the New Albany Shale which has the highest natural gamma ray activity on the geophysical log. In

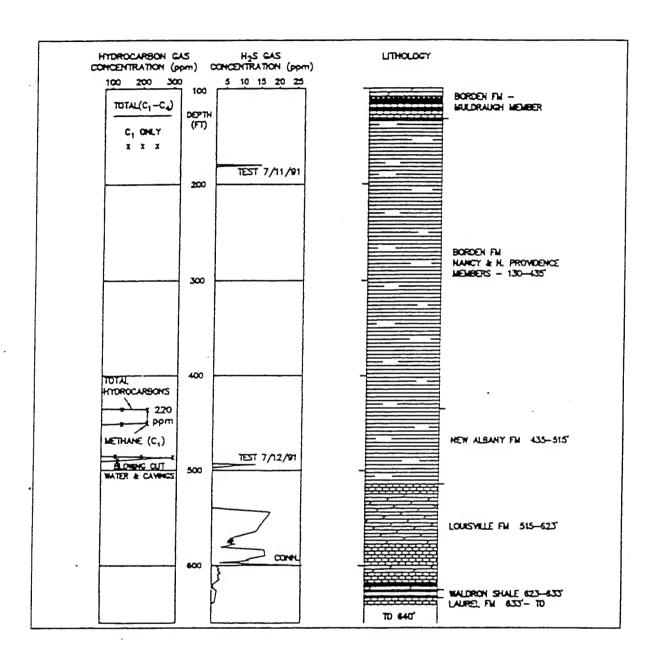


Figure 3-6. Formation Gas Log for Boring GTB-1.

previous studies, this interval has been shown to possess the highest organic material content in the form of kerogen as well (Reference 7.2 in GEOTECH REPORT). Samples of this material have been triaxially tested in the laboratory and have been observed to release hydrocarbon gas after testing. Based on the formation gas detection operation, it was determined that small quantities of methane (CH_4) gas may be encountered as the adit is driven through the upper portion of the New Albany Shale.

The presence of hydrogen sulfide (H_2S) gas in the UTP adit was another concern since it could represent a serious hazard to personnel. In an attempt to detect the presence and measure levels of hydrogen sulfide gas, two types of sensors, one active (Metal Oxide Detector) and one passive (Lead Acetate Paper), were employed to monitor the exit air stream while drilling borehole GTB-1. The data obtained from that monitoring program is displayed adjacent to the lithologic log and stratigraphic column in Figure 3-6 It can be clearly seen that the occurrance of H_2S corresponds to the upper porosity zone in the Louisville Formation.

The formation gas monitoring project resulted in the detection of both hydrocarbon and hydrogen sulfide gases. Each was identified in distinct and isolated intervals.

During construction of main adit, methane (CH₄) gas was encountered in the top 2 to 3 feet of the New Albany Shale, as gas perculated from two 0.1-inch wide, calcite filled, open vertical joints in the New Albany Shale in the adit invert at approximate station 18+50. Analysis of the air/gas samples taken revealed that the emitted gas was 98 percent methane (CH₄) with the remainder being primarily carbon dioxide (CO₂) and ethane (C₂H₆). Concentrations for samples taken at adit face were 24 ppm of CH₄ on the left side, 463 and 155 ppm CH₄ at center (2 samples), and 64 ppm CH₄ at right side. Hydrogen sulfide gas was not encountered, since no tunneling in the Louisville Carbonate Formation was performed.

3.4 UNDERGROUND GEOLOGIC MAPPING .

The Full Periphery Method (developed by the U.S. Corps of Engineers) was adopted for mapping the underground geology encountered in the excavation of the adit. The mapping indicated that the New Providence Shale was massive with few discontinuities. Five vertically oriented, bentonite filled joints were encountered in the first 50 feet of the main adit excavation. Another set of tight, mostly vertical joints was encountered between Station 2+29 and Station 2+35. As noted in Section 3.3.2, There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62.

Cobble-size siderite intrusions occurred frequently throughtout the New Providence Shale and one 8 inch thick siderite dike was encountered in the main adit from Station 15+64 to Station 16+54 and continued on in the test adit to Station C 3+10. The New Providence Shale started displaying organic laminar deposition patterns at about Station 15+00, where shale started to have horizontal bands of olive-green to grayish green coloration that became increasingly dominating and distinct as excavation advanced deeper into the New Providence Shale towards interface with the dark brown colored New Albany Shale (encountered at Station 15+34). Detailed geologic maps are presented in Appendix C.

3.5 SITE HYDROGEOLOGY .

The test site selection criteria required a saturated carbonate section at the test depth, therefore, a discussion of the hydrology of area becomes necessary to complete the description of the geology of site area. Two hydrologic regimes are discussed, the soil water, and the water within the rock units. Please refer to Section 3.3.3, Hydraulic Testing and Water Sampling, for details of hydrological testing performed for the UTP.

3.5.1 Soil Water.

The valleys contain a shallow perched water table. Boreholes drilled at various locations within the Rodgers Hollow area, below the grade change controlled by the weathering of the rock slopes, all indicated the presence of the shallow water table. The recorded piezometric levels showed a remarkable seasonal dependence. For example, the water table at a site a small distance up the valley from the portal area had been observed at a depth of 2 to 4 feet below the surface in February to April, and as deep as 9 or 10 feet in August through early November. This perched aquifer exists only at elevations within the valley proper and below the portal elevation, so that it should not be a factor in either portal construction or within the adit.

3.5.2 Rock Hydrology .

The hydrology of the rock materials affects the design parameters of the adit construction. For the purposes of this discussion, the rock hydrology will be divided into three zones: the Shale Zone; the Louisville Carbonate Zone; and the Deep Zone, i.e. the Waldron Formation into the Laurel Dolomite (Laurel Zone).

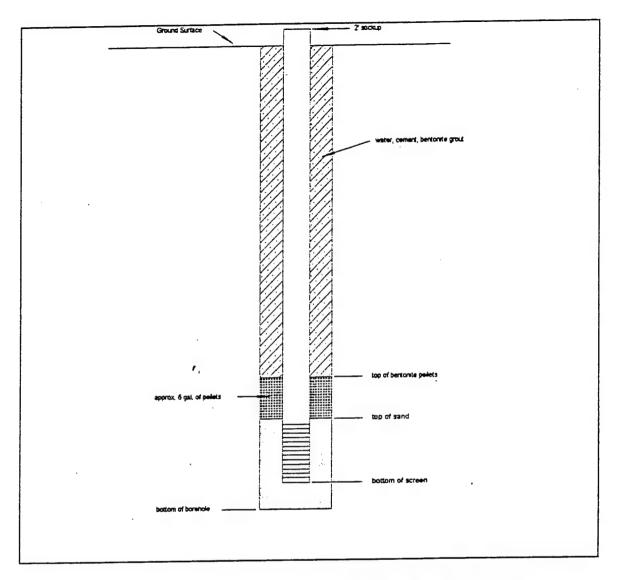


Figure 3-7. Typical Profile of Installed Piezometers.

- 3.5.2.1 <u>Shale Hydrology</u>. All of the shale units encountered above the Louisville Carbonate give evidence of 100 percent water saturation. However, no noticeable water flow has been encountered while drilling within the Borden or New Albany Shales. Thus, from a hydrologic engineering standpoint, only minor water seepage would be expected while tunneling through the shales.
- 3.5.2.2 Louisville Carbonate Hydrology. Two zones of water flow within the Louisville Carbonate have been detected and hydrologically tested. The upper zone is variable in thickness, but the base of the zone lies 35 to 40 feet below the base of the New Albany Shale. This zone is identified as the major water producing zone of the site. The lower water-bearing zone of the Louisville lies approximately 20 feet above the underlying Waldron Shale. This zone is also variable in thickness and permeability, but can generally be classified as less water-productive than the upper zone.
- 3.5.2.3 <u>Deep (Laurel) Hydrology</u>. The only recognized potential water zone below the Louisville Carbonate at the site is a zone within the Laurel Dolomite. There is relatively little known about this zone since it lies below the depth of interest for testing. Where this formation was penetrated by boreholes, it was found that it is located about 15 feet below the base of the Waldron Shale at approximately the 650 feet depth (as encountered in boreholes CB-5 and CB-6). The fluid conductivity/temperature geophysical logs do not demonstrate significant fluid entry from this zone, although the reservoir properties suggest it could be a water-bearing strata of minor to intermediate importance.

3.6 HYDROLOGIC MONITORING .

A total of seven piezometers were installed in 1993 during construction of the test adit by the WES crew at boreholes GWMH-4, GTB-1, P-1, P-2, CS-5, CS-6, and CS-7 to monitor the water table in the Louisville Formation Reservoir, prior to and during the penetration of the main adit. The data collected provided quick and accurate feedback on depletability, drainage profiles, and the pressure drop of the reservoir as the main adit was constructed, and also provided the means necessary to determine if remedial steps were needed to be implimented so that the saturation of the Carbonate Formation could be maintained as required by the test parameters. A profile of a typical piezometer installation is shown in Figure 3-7 at left, and the locations of the piezometers are shown in Figure 3-8 on the next page.

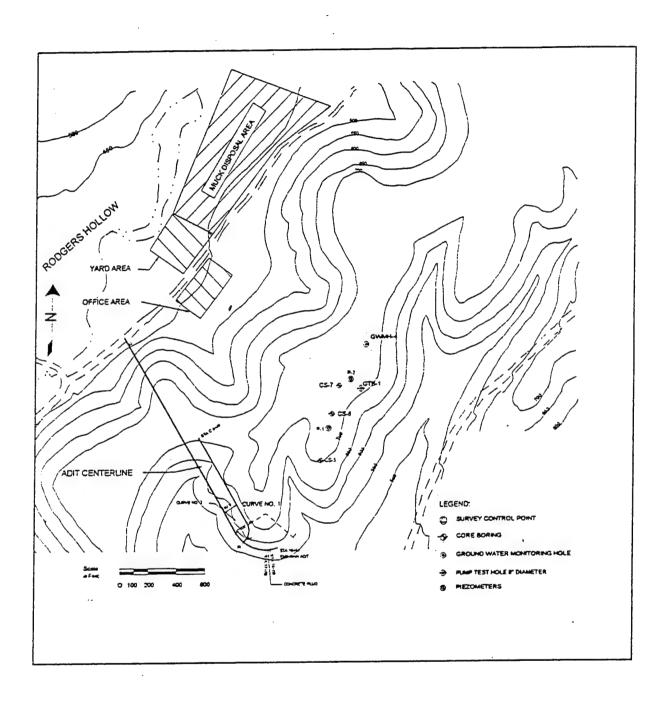


Figure 3-8. Location Map of Installed Piezometers.

SECTION 4

CONSTRUCTION METHODS

4.1 GENERAL .

A Request for Proposals (RFP), Solicitation No. DACA27-92-R-003 Underground Technology Program, Test Adit Construction, was issued in May, 1992 by the U.S. Army Engineer District, Louisville. A total of ten proposals were received in June, 1992 and, after evaluation of the proposals, a contract was awarded in July, 1992 to W.L. Hailey & Co., Inc. of Nashville, Tennessee. The contract provided for a one year construction period for the completion of the test adit and all appurtenant features of the permanent work.

The contractor began mobilization at the site in early August, 1992 and completed the initial site work, office set up, and site preparation, on October 20, 1992. Portal construction commenced on October 13, 1992, with the clearing of the portal area and the backfill of the structure was completed on December 23, 1992. Tunnel excavation commenced on December 28, 1992, and progressed to Station 18+54 on June 25, 1993, at which time methane gas was encountered in the heading and the tunnel excavation was halted. Work in the tunnel resumed on November 8, 1993, with the installation of vent line hangers in the main adit. The gas collection system was installed between November 15 to November 18, 1993 and the containment plug was constructed between November 22, 1993 and February 28, 1994. The test adit was excavated concurrently with the containment plug construction between November 22, 1993, and February 11, 1994. The balance of the contract work, electrical, mechanical, invert placement, shotcrete lining and final tunnel clean up was performed from March 1, 1994 through May 7, 1994.

4.2 PORTAL CONSTRUCTION .

The portal construction involved an open cut excavation of both overburden and shale. The overburden material was excavated using a dozer, loader, and dump trucks. The side slopes of the overburden excavation were laid back, thereby eliminating the need for the support of excavation structure. The shale cut was excavated utilizing drill and blast methods to break the rock, and a loader and dump trucks to excavate the shot rock. The side slopes of the rock cut were excavated with a slight outward batter to eliminate the need for any rock support.

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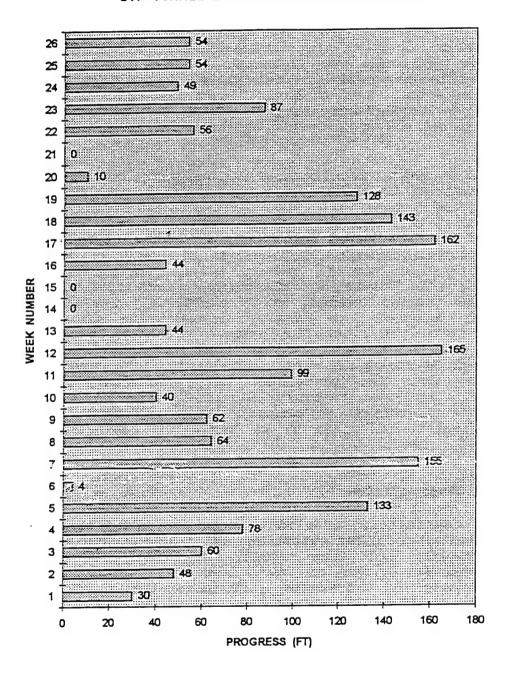


Figure 4-1. Tunnel Progress Summary, (Chart 1 of 2).

After completion of the excavation, the steel ribs (W6x25s) were installed and the concrete invert poured. The 6 inch thick wire reinforced shotcrete was then placed between the ribs and the structure was backfilled. The reinforced concrete U-Wall structure was built by normal cast-in-place methods with wood forms.

4.3 ADIT EXCAVATION .

Tunneling operations commenced on December 28, 1992, at Station 0+94 using a Voest-Alpine Roadheader to mine the shale, and a pair of 5 cubic yard Eimco low profile mine trucks were used for muck removal. The contractor selected this type of equipment for excavating the the shales because it provided a more continuous mining operation. This method significantly reduced overexcavation, and eliminated many of the safety hazards that are inherent in a drill and blast operation.

Throughout the tunnel excavation, the contractor mined the required cross section with minimal variance, and maintained line and grade well within tolerances. The roadheader and heading crews limited overexcavation and minimized the disturbance to the rock beyond design line. However, the actual advance rates for the roadheader operation never approached the anticipated rates. The estimated production rates for the roadheader excavation were an average of 15 linear feet of advance per 8 hour shift after an initial startup period. The contractor was prepared to mine two shifts per day and use a third shift to install ground support and tunnel utilities, as well as maintain the mining equipment. In this way, he had planned to mine and support an average of 30 linear feet per day, or 150 linear feet of tunnel per five day work week.

In the period from December 28, 1992 to June 25, 1993, the contractor worked a total of 141 days and mined 1,760 linear feet of adit. The overall average for this period was 12.5 feet per day and 67.7 feet per week. There were only six weeks in which production levels exceeded 100 feet per week, and the best weekly production was 165 feet. At left, Figure 4-1, provides the weekly advance rates for the first twenty-six weeks. The rates for the remainder of the project may be found on the following page. Of the total 141 day project duration, the contractor was able to mine on 89 days, and lost a total of 52 days for the following reasons: 13 days were spent on ground support installation; 12 days due to equipment breakdowns; 12 days for concrete operations on the invert; 8 days for ventilation system installation; and 7 days due to inclement weather.

On June 25, 1993, methane gas was detected in the tunnel at Station 18+54. The quantity and duration of the gas entering the

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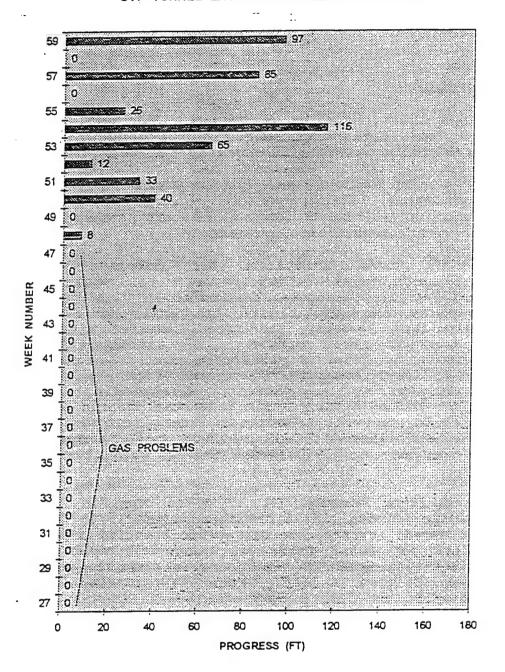


Figure 4-1. Tunnel Progress Summary (Chart 2 of 2), (Continued).

tunnel was sufficient to require that the tunnel be re-classified as a "gassy" tunnel. Mining operations were discontinued for a period of 23 weeks while alternate plans were developed to deal with the gassy conditions. As noted in Section 2.3.3, Differing Site Condition, the decision was made to terminate the main adit at Station 18+54, seal the tunnel with a gas containment plug from Station 17+70 to Station 18+00, and to realign the test adit to remain totally within the New Providence Shale.

The test adit was excavated from Station C 0+06 to C 5+24 during the period of November 22, 1993 to February 11, 1994 and utilized the same equipment and methods as the main adit. Unlike the main adit, the test adit was excavated essentially on a single shift basis, four days per week. The average production rate for the 518 linear feet of tunnel was 13 feet per day on a single shift basis, which is more than twice the advance rate achieved in the main adit. Figure 4-1, Chart 2 of 2, at left shows the weekly advance rates in the test adit.

4.4 GROUND SUPPORT .

As discussed in Section 2.2.5, Ground Support, there were four types of ground support provided for the contract, with the determination of which type to employ, made in the field as the excavation progressed. As anticipated, the New Providence Shale was massive and competent, and required very little direct ground support. A total of six steel sets were installed at the beginning of the adit from Station 0+94 to Station 1+18. A total of twenty-two rock bolts and twelve rock dowels were installed in the main adit from Station 1+22 to Station 2+36. The permanent support for the sump bay (Station 14+54) and transformer bay (Station 15+16) consisted of a total of 101 rock bolts, and the support of the adit intersection (Station 16+00) consisted of seventy-two rock dowels.

The only area of the main adit which required a substantial number of rock dowels was from Station 16+56 to Station 18+46. In this reach of the tunnel, the New Providence Shale had a tendency to spall and ravel at crown of tunnel when the heading face advanced two tunnel diameters further. As the excavation progressed, the New Providence Shale became more organic and displayed planar, thin, lamination layers at crown, beginning at Station 15+02. At approximately Station 16+60, spalling of rock from crown started occurring more frequently, and the size of the spalled rock fragments increased to approximately 1 foot wide by 2 foot long and 2 to 3 inches thick. Even though the shale formation was still massive and structurally self-supporting, the spalling posed a safety hazard to the workmen in the heading, and the contractor was directed to install rock dowels from Station 16+56 to the

Table 4-1. Summary of UTP-Permanent Support Utilized.

ADIT STATION	TYPE OF SUPPORT INSTALLED
0+94 to 1+18	Steel ribs (6 ea)
1+22 to 1+33	Spot rock dowels (16 ea)
1+45 to 1+51	Spot rock bolts (12 ea)
2+32 to 2+36	Spot rock bolts (6 ea)
5+68 to 5+80	Spot rock bolts
14+35 to 15+38 (Sump Bay)	Patterned rock bolts (47 ea)
14+93 to 15+38 (Transformer Bay)	Patterned rock bolts (57 ea)
15+80 to 16+20 and C 0+12 to C 0+21 (Intersection)	Patterned rock bolts (72 ea)
16+56 to 18+46	Patterned rock bolts (212 ea) (with wire mesh from 17+58 to 18+44)

face, located at Station 17+35, before any further advance of the heading. The contractor was also directed to have rock dowels installed within 15 feet of the face at all times. Therefore, patterned rock dowels were installed from Station 16+56 to Station 18+46. Table 4-1 lists the different support systems used and their location in test adit.

All rock bolts and rock dowels were fully resin-encapsulated Number 8 threaded rebar, Grade 60 steel. The typical bolt/dowel length was 8 feet except for a number of 10 foot long bolts which were used at the sump and transformer bays and at the adit intersection.

While the adits required only minimal direct ground support for safety and stability, the New Providence Shale did require a shotcrete lining to permanently seal the excavated surface to prevent long-term deterioration of the shale due to air slaking. A nominal 2-inch thickness of shotcrete was applied throughout the entire length of both the main and test adits, and a 4 inch thickness was applied to the intersection area of the two adits.

4.5 GROUNDWATER OCCURRENCES .

The only measurable water inflow encountered during tunneling was at the top of the New Albany Shale at Station 18+50. While the water inflow, estimated at less than 5 gpm, presented no problem to the excavation, the water was accompanied by methane gas. The impact of the methane gas is discussed in detail in Section 2.3.3, Differing Site Condition.

SECTION 5

TUNNEL INSTRUMENTATION

5.1 TAPE EXTENSOMETERS .

A total of six sets (four points each) of convergence points were provided in the bid schedule. These convergence points were to be installed as needed in the main and calibration adits to monitor movements of the tunnel lining in areas where the geological conditions warranted. Due to the massive nature of the New Providence Shale, only one set was required, and the instrument was installed in the main adit at Station 1+20 to monitor any movement close to the portal. A total of four readings were taken in the period from February 3, to February 8, 1993. The data obtained from these readings indicated that the movements were negligible and stabilized quickly.

5.2 SINGLE POINT BOREHOLE EXTENSOMETERS .

None of the six sets of Single Point Borehole Extensometers (SPBXs) that were provided for in the contract were required in the New Providence Shale, and none were installed.

SECTION 6

REFERENCES

- Pitts Point Geologic Quadrangle Map, USGS Publication, 1976.
- 2 <u>UNDERGROUND TECHNOLOGY PROGRAM</u>, Geotechnical Design Summary Report, Volume 1.
- 3 <u>UNDERGROUND TECHNOLOGY PROGRAM</u>, Geotechnical Design Summary Report, Volume 2.
- "Petrophysical Analysis US Army Corps of Engineers Hole FK-1, Bullitt County, Kentucky", ResTech Inc., Houston Report, April 1990, Houston, Texas.
- 5 <u>Underground Technology Program, Test Adit Construction</u>, Solicitation No. DACA27-92-R-003, US Army Engineer District, Louisville, Kentucky, May, 1992.
- Rock Engineering, J.A. Franklin and M.B. Dusseault, McGraw-Hill, New York, 1989.

Appendix A Geologic Core Logs

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	=	- / - ,					
		-4-4					-1
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	=	7 7					
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	-						1
		L_{-}					-
	=	/ /					-
	-	- /					-
	-	7/7	· —				
		 					1
1	594 =	_/	Run (11) 584-594				
	~ _	//					ı
	_	7	Same L.S. as in			DJ. = 80	1
1	_	-7	previous run with			wi = 50 %	-
- 1	_	77	vertical fractures			,	-
	_	7/				Recou. 9.3	
	=	17	and two broken rock			•	1
- 1	П	7'-	Zones @ 588.3-588				I
1		4					١
l			£ 593 - 593.C			•	١
	_ =	_/_	And the American				1
		4,4	where drilling rod				ı
	_	,/,	dropped.			* plendy of pyrite	1
	-	/// /	i la la la la la la la la la la la la la			at broken rock	ł
l l		4-4	Top 2 feet non porons,				ł
ĺ	_	4				Zones .	ı
- 1	=	4	fine grained getting			* A vertical pyrite	ı
1	_	_/_/	porous & broken @			_	ł
		/				Seam @ 587.7-	ŀ
			587.5- 589 w/ plenty			590.0	-
]		4	of pyrite velus.				ı
i		4/	Rest of core is mod.				١
]	-						ı
Ì	=	-4.	evious.				ŀ
ļ		/_,				•	ı
ľ		/_/	-3' thick quartz				١
			interbed @ 586.1-586.	4			ı
	-						Ì
1	594	1/	RUN (12) 594-604	1			-
	<i></i>	1. 7.					-
	=		Light gray porous			D.T. = 40 min	
- 1	=	_/_	_			WL = 100 %	
.	_	//	L.s. w/ plenty of				
1	=		quarte getting less			Recou. 9.9'	J
İ		11		'			1
		17	ct 8PE @ cuorog				1
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1	. =	1_1	bottom.				
		/	Core has a work				١
							١
Ì			Pelled odor.				١
1	7						1
		17					١
ŀ		7.				. •	- 1
	-	/-					1
	7	11	•			•	١
		I					-
		11					١
		/	A-7				١
		/ / 1					- 1

OMC		•	Sheet) REVASION for or HOLE	PERMATEN			Hole No.	CS-I
					-			or setts
MOTAVA	DEFTH	ucee	, GASSPICATION OF		SECON- ESCON-	SAMPLE NO.	(Drilling size, a	ARKS weer law, depole of , if significant)
	=	17				,		t
	=	7						
- 1	=	/ 						
- 1		1						
Ì		17	1					
	604]		Run (13) 604-	609				
	=	4	604 - 605 tan	mish gray			WL 4 100	*/_
	Ξ	171	ms. changing t	- darker			07.= 40	
	ヿ	/_/	greenish gray L grained, unwealth	·s., line		- 1	Recovi. =	4.4
	Ξ	.,					•	
}	7	/	Plenty of soll	2.com		.]		
- 1	\pm	-/-	horis. lenses.					
	7	1/7	Core is nonpor		- 1	ı		
- 1	=	1 1	is is the			- 1		
ŀ		/						
1	609	/_ /	Run (14) 609 -	45.5				
	=	1.1	609 - 612.5				WL = 100	•,
	4	-/-				- 1	DT = ?	's
	7	/_/	L.S. , non por	, ,	ł		טויי י	
	3	/_/	mod. fine grain			1	Recov.	7.2
	=	//	changing to	ramish				
ł	3	7	gray L.s. w			- 1		
	=		to pottom of	CATE .		1		
	34	4						
	3	4						
	37	7				1		
•	3	Z_4			- 1			•
	\exists_7	-/- 						
اعا	5.5	\Box	Run (15) 615.5-	625.5				
1	=	74	615.5 - 617				Recou.	a '
	=	1		5.				
	3		as in previous		İ		W/ = 10.	
	===	7.	changing to sh	ماح د.د.			0.7 4	o maisas
	_=	/-/	ci7 - ciq (dork	er aren				
	===		Hara da .	33)			D	
CI	4_4		then to greeni	or asan		1	Pres. Core:	
			thinly lawrate	a shale.			618 - 61q.	
	3						621.75- 67	
	3_						623-55-6	24.6
	+	-		.		ŀ		ļ
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DRILLING	. 100	(Cont :	Sheet) REVAI					Hole No.	cs-1
PROJECT	•				METALLATION	_			SHEET 7
			GAS	MICATION OF	MATERIALS	% CORE	SOX OR	H	MARKS
BLEVATION	DEPTH	TECONO.		(Derripsia	,	EECOV-	SAMPLE NO.	(Drilling sine. washering, o	water lass, depth te., if significant)
•	.	c		4		•			
	05.5		Run (16)	625.	5- 630.5		1 1		
	_ =				dark			Recov.	5'
	=		023-3	- 621	dark				
	=		Greeni	or also	shale			Wr = 10	, ·
	627		chang	ing to	hamish			Pres. Core	•
	" " ∃	ZZ	gray	L.S.	to		1 1	~~	-
		-/-,						625.5-	626-4
	1		pottor	~					
		/ <u>-</u>							
	=	-//							
	그	7,7		_	N.				
	630.5	-		Bo	#				
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	=	-			A-9				

CS-2 Hale No. SHEET \ DRILLING LOG PROJECT HE SIZE AND TYPE OF MY NO WITE YTP Ft. Knox , KY 12 MANUFACTURER'S DESIGNATION OF DRILL B-61 FMSM IL TOTAL NO. OF OVER-BUMDEN SAMPLES TAKEN C5-2 14. TOTAL HUNGER CORE BOXES Serber John IL ELEVATION GROUND WATER Dec. 16 92 ZVERTICAL MINCLINED 17. ELEVATION TOP OF HOLE 7. THICKNESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR SORING . DEPTH DRILLED INTO ROCK 142.4 H. SIGNATURE OF INSPECTOR . TOTAL DEPTH OF HOLE 642.4 S CORE BOX OR RECOVERY NO. REMARKS
(Drilling time, mater loce, depth of meathering, etc., if eignificant) CLASSIFICATION OF MATERIALS ELEMATION DEPTH LEGEND Hole pie drilled to soo yeath + cased for 95' Run (1) 500 - 505-4 Dark brown unweath. Water Loss = 0 New Albamy shale 5 . T.U with some gray Pres. colored banding at 500 - 500.8 top 2.5 of core. 501.3 - 502.1 Thinky Seminated, Fine 503.85 - 504.85 textured. Recov. 5.3 RUN 2 505.4 - 515.5 D.T. = 65 -in. Same shale with W.L. = \$ more discontinuties. Preserved: - some vertical -507.9 - 508.55 Frequent pyrite lenses 508.55 - 509.3 4 One Pyrite & L.S. 509.85 - 510.6 lens @ 505.65 - 505.9 510.6 - 511.35 514-4 - 515.15 Recov. 10.2 **A-11**

PROJECT

ENG FORM 18 36 PREVIOUS EDITIONS ARE OBSOLETE.

HILLING LOG (Cent Sheet) REVANDA TOP OF HOLE HOLE NO. CS-Z HEET Z									
				1	-	or svetts			
EVATION	067N1 2	utgano c	CLASSPICATION OF MATERIALS (Description)	SECOV-	BOX OR SAMPLE MO.	(Drilling sime, water law, depth of weathering, str., of significant)			
	315.5		Run (3) 515.5 - 525.5						
	""王	—	Some Shale to			Recov. 9.95'			
ı	Ξ					D.T. = 35 min			
	∄		519.3 Where Core			W.L. = 9			
	크		changes to Viggy,			•			
	3		Porous tannish gray	[Preserved Core:			
	╡		L.S.		ı	515.5 - 514.6			
9	M3 =	-	At 521.5 Yock change			516-6-517-65			
1	7	4 4	to finer grained,			518-25- 519-3			
	上	$\frac{f}{f}$	light gray to tamish						
	=	1	gray non porous L.S.	İ					
	\exists	-4		Ì	ľ				
	Ĭ	7							
	4	7.4							
	∄	4			1				
	3,		,						
	3	7							
	耳,	7							
51	2.5		Run (4) 525-5-535.8			·			
- 1	∄	4	Same L.S. as at			Recov. 10.25			
	\exists	\angle	pottom of previous run			D.T. = 30 -in.			
		74	changing to darker gray			ن. ـ . = ø			
52	1.6	7:7	shaly L.s. @ 527.6			Pres. core			
	<u></u>	/-/ .	which is unweathered,	Ì		528.2 - 529.1			
	=	7	fine textured with	l		529.1 - 529.9			
		4	some 9t2.			532.6 - 534			
	=7	I				534 - 535.8			
	4	1/							
	7	1-/		• 1					
	3.	F			1				
	7	1				Ì			
	7	7							
	7	1							
	37		·						
	37	' 							
	月	<u> </u>	Pun (5) 535.8 - 545.8						
435	·8 <u>±</u>	/ .	Shally 1.5. as above		-	D.T. = 30 m.n			
	34		changing (2 544.3			. C			
	===		to porous dark gray			w. L. = p			
	-	/ 1	L.S.			Recau. = 10'			
- 1	<u> </u>	4	A-12	1	- 1	t.			

RILLING	100	(Cont 3	ineet) ELEVATION TOP OF HOLE			Hole No. CS-Z
	T			-	1007 55	OF SHEETS
POTAVE	DEFTH	LEGENED	CLASSPICATION OF MATERIALS (Duraginia)	ERY	SAMPLE NO.	REMARKS (Drilling sime, water has, depth of weathering, ste., if significant)
4	-	//		•		
	=	7				Pres. Gre:
		7 7	L.S. gets less shally			
	1 =	-/-/)	@ 537.3 to bottom.			
	Ι Ξ	-//-"				
	=	7' 7				
	=	7				
	_	\mathcal{I}		Į.	1	
	1 3	4,1	•	ļ		
	-	4, ,				
	=	-4-4		1		
	_	-/				
	=	//				,
•	544.3	7				
	-	7-				
	_=	7 7		1		
	45.8	1 1	Run (6) 545.8 - 556			
	7 =	-/-/	L.S. porous, tamish			Recov. 10.2
	_	17-1		l		
		TT	gray , vuggy , slightly			D.T. = 25 min
	3	/_/	weathered 4 odorous			W-L- = # .
	-	4		1		•
	=	-/	Rock improves in		1	•
		-/-	quality at bottom 1			
	3	4/	(i.e. 555-556)			
		-/ -/				
	=	///	Some gray shale			
		7/1	Veins.	}		
	=	77		1		
	Ξ	III				
	\exists	/_		1		
	=]		
	_	//				
	. 3	// /	•	i .		
	-	-//		l		
	=	-/]		
	_ =	77				
	3	77			}	
	_=	44	0 - Per mai maa			
	556 =	7/7	Run (7) 556- == 566	·		
	=	77	same light gray			Recou. 10'
		\mathcal{I}	non porous L. s.			0.7
	=		as at boltom of last			0.7. = ?
		[, المسرك	run changing @ 599.5			W.L. = 96
	=	ا4-ر /	to tannish gray, poron	ļ		
	-	4,-,	silly. worth. L.s. w/v	unas.	'	
	3	-4-1-	•	177.		
	E	, 	Some gray shade			
	=	''	veins.			
	=	//	6			
		7/	Smells like H25.		.	
]	Z = Z				•
	\exists	//	•			
	=	, 77	A-13			
	-	/ /	M-13	MORCI		HOLE NO.

ici		(COM :	Sheet) EZVAZON TOP OF HOLE			Hole No. C5-2
	T		CASSPICATION OF MATERIALS	# CORE	SAMPLE	CO SHEETS REMARKS (Drilling sime, major bear, depth of
ANOH	DEFTH	rice-c	(Duriphin)	22V	HO.	weathering, see, if agrifaces)
	=	17				
	=	11				
	=	/_/				
		77				
	3	7	•			
	3	7				
	566	_/	Run (8) 566 - 576			
	=	-4-/	Tamish gray L.S.			Recov. 10'
	E	4	silly, weathered 4			D.T. = 40 min.
	=	474	frequently jointed			W.L 9
	F	17.1	at 568-5 - 574-6			·
	=	-/-)				
	ΙŒ	//	m/ some borosity.			•
	=	7	Some gray shale veins.			
	=	/ 	Odorous.			
	=	1/				•
	日	\mathcal{I}				
		' 				•
	=	7			-	
	Ξ	41				•
	+	///				
ı	三	/ /				•
-	3	//				
İ	=	7				
i	#	//				•
	<u></u>	74	Run (9) 576-586.2			
- 1	576	7,1	SW tannish gray			w. L. = >
ļ	7	///	L.s. as above.			D.T ?
1	1	T'	Non-porons, coarse		j	,
	4	4,7	grained with shall			Recov. 10-2
	=	1	lenses & veins.	,	.	
	王	7			.	
	₹ =	\sqrt{A}				
-	7	/-/				
	=+	7-			.	
	=7	\mathcal{I}			- 1	
	크,	/_/				
	∃"	T'				
	3	/_/		l		
	E	4		[
	4	7-				
	₹					•
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	∃4	- 4			Ì	·
	<u></u>	//	•			
5	86.2		A-14			
	1836-A			POJECT		HOLE NO.

DRILLING LOG (Cont Sheet) REVATION BETT LEGEND CASSIFICATION OF MATERIALS (Description) A CASSIFICATION OF MATERIALS (Description) A CASSIFICATION OF MATERIALS (Description) (SHEFT S OF SHEETS ELSS ELSS ELSS ELSS ELSS ELSS ELSS
Same L.S. as in Recov. 1 Previous run 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	NES or loss, depth of if significant)
Same L.S. as in Recov. 1 Previous run 1.7. = 50	
Same L.S. as in Recov. 1 Previous Yum 0.T. = 50	
Same L.S. as in Recov. 1 Previous Yum 0.T. = 50	
- 7/7 previous rum 0.T. = 50	
1 1 3-4-1 '	min.
	\$
= 77	
 /-/	
1 1 3 4 4	
$\frac{1}{2}$	
$\frac{1}{2}$	
 / 	
= 1/2/	
]/ 	
596.4 - (11) 596.4 - 606.3	
Same L.S. as above Kecov.	
changing @ 602 to D.T. = 5	
pinkish gray, porons	
ביש ביש ביש בישור א	
fetted abor.	
1 \$\frac{1}{2} \rightarrow	
= 44	·
=	
] / 	
= 1/7/	
= -	
 / 	
66-3-1 Run (12) 606-3-616-3	
Porous pinkish gray Recov. 9.	·8 ′
Vugog L.S. with	
frequent discontinuities	
to darker A-15 h	

PRILLING	LOG	(Cont :	Sheet) REVAION for Or HOLE			Hole No. C5-Z	_
			DISTALLARON	-		seri 6 or seri	s
BEYATION	ретн Ъ	LEGENO C	CLASSIFICATION OF MATERIALS (Dumprins)	% COE	SAMPLE HO.	(Drilling sime, maser less, depth or seasthering, star, if againstant)	4
		//	gray L.S. with				
	=	1	plenty of 9tz mix.	اد		,	
- 1	\exists	44	with the L.S.				
1	=	44	WITH THE LOS.				
- 1	7	-/-	Non porous to silly				
.	. =		parous				
- 1	ㅋ	7		1			
- 1	Ξ	1					
.	⊣	/	•				
- 1	=	$\angle Z$					
	-∃.						
	#	44			Ì		
	4	4		.			
- 1	3	4 4			1		
16	16:37		Run (13) 616-3 - 626-3				
		/	Sam as above to			Recov. 9.7	_
	. 3-	54	624.8 Where it 9	ets	ŀ		
	=					0.T. = 30 -in	
- 1	3	7	tannish - gray and	1 1	ł	w. L pt	
	$\exists \tilde{z}$	7	coarser grained				
- 1	7	_4					
	3	-4					
	+				.		
1	3	74.	•		1		
	===	77					
	E	Z ·					
	= -	44					
- 1	3	/	•				
1	7						ŀ
1	五	7					
j	3.7						Ė
j	7	$\mathcal{I}_{\mathbf{J}}$					F
[3/	-/					ŀ
	7	- /		1 1	İ		
626.3	. 3Z	_ p	un (14) 676 3 - 636.3				þ
646.)	3/	_ /I _		-			
- 1	丑		Tomish gray L.s. as			D-T. = 30 min.	Ė
1.	34	4 '	above changing @			w. L. = 91	E
j	3-	→ '	28.8 to shaly	•			F
	3		s. down to 630.1		8	res. core:	E
528-	* 封	/ 1	grading again to		_	632.7 - 634	þ
	-127	_				•	E
	7	7	ark gray limy shale		- 1 '	634.2 - 635.55	E
			own to 632.			•	F
ŀ	-	2 اير	32 - 636.2 gray		6	2ccou. 9-9'	E
	-1 7		valdron shale		1.	• •	E
		-/-1	mweath, mod. Soft	1 1			F
(3)] -						E
	7		A-16				F

CILLING	LOG	(Cont :	Sheet) REVATION TOP OF HOL				Hole No.	
DJACT .				DISTALLATION		-		OF SPETS
EVATION	DEFTH	LEGENE	CLASSIFICATION OF		% CORE	BOX OR	Christian size	MARKS mater day, depth of
	ь		(Descriptions	,	ERY	NO.	masterial, a	e, if significant)
•	-	-	•		•			
	=				ĺ			
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	-							•
	-					i		
	,=							
	برون مون		Run (15) 636.	3-642-4				
	=		Top 10 638					
	=		waldron shall				Pres. co	<u> </u>
			unweath.	2			636.6 -	631.6
	=						637.6 -	
	(A)-	7 /	638 - 639.8	لاست				
	ľŦ	/	shale.				_	
		77	639.8 - Box				Recou.	6.4
			1.0 - DO	T tannish				
	639.8	7	gray L.S.	שווקאווש		1		
	•"'	11	perous.			1		
	=	11				1	•	
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	\exists			A-17				•

Hole No. C5-3 TALLATION DRILLING LOG OF 7 SHEETS PROJECT 11. DATUM FOR ECEVATION SHOWN (75H at MEL) U TP 2. LOCATION (C. FI. Knox , KY 12. MANUFACTURER'S DESIGNATION OF DRILL FHSM 12. TOTAL NO. OF OVER-HOLE NO. (A. a C5-3 14. TOTAL HUMBER CORE BOXES HAME OF DRILLER ~doZ Serber IL ELEVATION GROUND WATER ML DATE HOLE Dec. 29 Jan. 4 , 93 TYPERTICAL | INCLINED. 17. ELEVATION TOP OF HOLE . THICKHESS OF OVERBURDEN 18. TOTAL CORE RECOVERY FOR SORING DEPTH SRILLED INTO ROCK 139.6 19. SIGNATURE OF INSPECTOR Alsayab 639.45 Ghailan S COME BOX OR SAMPLE HO. REMARKS
(Drilling time, major less, depth of meditoring, one., if significant) ELEVATION DEPTH LEGEND CLASSIFICATION OF MATERIALS Hole pre drilled to 499.8' & cased down to 95' 499.8 Run (1) 499.8 - 505 Dark brown Shale D.T. .. (New Albany) الع ند ۱۰ دیا unweath, frequently Recov. 5 jointed, with Pres. Core: some pyrite lenses 502-53 - 503-15 503-15 - 503-75 Run (2) 505 - 514 shale - same as Recour 8.8 above. DT. = 40 min w L. . % Pres core: 5115.35 - 506.01 507.7 - 508.55 508:55 - 509.4 509.4 - 510.45 511.2 - 511.95 511.45 - 513.55 Run (3) 514 - 524 514 - 517.5 New Albany Recov. 10.2' shale as above changi D.T. : 90 min . at 517.5 to tannish W.L. = y gray L.S. , porous .

MC	LOG	(Conf :	Sheet) MAYARON ROP OF HOLE	MATION			Hale No.	C5-3
			9414	MARKET				STEEM TO
EVATION	DEFIN	uca-e	CLASSIFICATION OF MATE	BALS.	RECOV.	SAMPLE	(Drilling sine, w	ARKS
•	•	e		·	ERY	HO.	mandering, as	. if myneficial) B
l	=		At 520 Lis.				Pres. Co	· :
	Ξ	/	non porous & si	haly.				_
		//) () a) !				515.5-	517-05
	3	11	L.S. has plant	•¥				
- 1	Ξ	11	mixed glz.					
1	=	44						
1	\exists			j				
1	=	4						
	\equiv	1-1-			- 1			
	⇉	[- -			1			
	\exists	17			1	.		
	- ₹	户		i		- 1		
1	ㅋ	17		İ		ł		
	24 -	17	Run (4) 524 - 534	1.3	- 1	ł		
٩	- 1	7					0	-
	- ₹	母,	524-525.8 ligh	× 2.2	- 1		Recou. 10	
	1	71	nen perons L.S.			- [D.T. = 0	le min
-	=	FL	525.8 - 526.2 L	_	1	1	w. L. = *	
	-	1/2	mixed w/ gray	1		- 1	•	
1	32	7	setting shally	V.5.			Pres. Core:	
		7	526.2 - bollom .]	- 1	- 1	526.2 - 52	
	=======================================		Fine grained, no	~0070u k			528 - 65 -	
	==	1/	and unweathered	· 1	'		531 - 53	
	=	7				ĺ	532.5 - 5	33.7
	3	$\frac{Z}{Z}$						
	4.	£1						
	7	11						
	_=17	11		l				
	\exists	41			1	1		
1	Ĭ/	1						
	7	/-/		1				
	3							
	==	左7 .						
	3	-	Pun (5) 534-3 - 5	44.3				
53	4.3						Recou. 10	, .
		4 1	shally List, Same					
	17		above with blende	4			D.T. * S	
	-1/	_/	fuartz.				کو ید ۱۰۱۰ب	
	37	7	-5. gets less she				•	
	一		courser grained				Pres. Gie:	
	$\exists Z$		541.5 to bottom				534.3 - 53	
		Ξ	544 - 344.3 Cem	ا_و_	ŀ		36.8 - 53	
	*	<u> </u>	yray L.S.				38-2 - 531	
	-12	7	- J			5	40.3 - 541	. 45
	32	=		1		15	41.65 - 54	3.2
	→	王,	•					
}	====	=	A-2	20				
	- /= 36-A	-7!	F-1-1801) and 1999 as - 410-1	20 /20				

PHLING	LOG	(Cont S	heet) BLEVATION TOP OF HOLE			Hole No. C5-3
TOMO!		(00	PRETALLATION		_	sett 3
				* 5000	AOX OR	OF SHEETS
BLEVATION	DEFTH	LEGENO.	CLASSIFICATION OF MATERIALS (Description)	SECOV.	BOX OR SAMPLE NO.	(Drilling sime, water last, depth of weathering, etc., if seguificant)
	•	c	d		1	
		44		1		
	_	1		ł		
	=	77				·
		77	•	Ì		
	_	179				
	=	1				
	544·3-	1-1	Run (6) 544.3 - 554.6			
	544.2	44	Light gray L.S. with			Recov. 10.3
	_	1,1				D.T. = 60 min
	=	4	plenty of 912, porous,			w.L. = p5
	-	77	unweath, with fetted	1		7
	_	11	odor.			
	=	1,1	Frequently jointed		i i	
	-	1	1 - 3 -	}		
	=	1//				
	-	1				
	=	11				
	_	7.7				1
	-	1,/,/				
	=	/_/ _			1	
		1//				
	=	1/		1		
	_	44				
	=	1,-4		1	1 .	
	-	4	•		1	
	=	177		1		
	_	144				
	=	1-4-4		1		
		ンナ				
	564.4	17	Run (7) 554.6 - 364.4	.	ļ	
	-	144	554.6- 555.1 light +	hnish		Recov. 4.8
		1//	554.6- 55511	1		\$ = .7.0
	:		gray mostly non porous		1	
	-	44	L.S., frequently jointe	9		w.L. = ø
		1//	changing @ 555.1 to	559.1	+	
	-	7.7	to light gray slightly			
	=	14-4	perous L.S.			1
	-	1/1	Frequent discontin.			
		7.7				1
	-	14-	plenty of ate.		1	
	3	1//	559.4 - 564.4 tannis			l .
	-	ZZ	gray L.S. again.		1	
	:	14.1			1	1
	-	177	Felted odor.			
		1,7,				1
	3	+ 4	1			
	=	1/]	1		
	:	1,1,	1			
	-	144	1			
	:	177				
	-	1///				
	1 -	- ///	i -	1		I

DANCT		•	iheet) MEANARON TOP OF HOLE	Hole No. C5-3				
EVATION	DEFTH	uca-o	CLASSIFICATION OF MATERIALS	1. CORE RECOV- ERY	SOX OR SAMPLE NO.	· esmaexs		
•	•	1/	4	•	-			
	=	11	Run (8) 564.4 - 573.75			Dec. 31 , 92		
	54.4 <u> </u>	11				,		
	=	1/1	Same tan gray	-		Recov. = 9.35		
	=	4	L.S. as above			D.T. = ?		
		1,1	w/ fetted odor.			w.L. = Ø		
	_	7,7,	mod. porous.					
	=	1/						
		11	•					
	=	1,4						
	· =	11						
	=	4/						
	\exists	11						
	=	1,1,1						
	\exists	1/1						
	3	11						
	\exists	7,7						
	. 🗦	11						
	E	,7,4						
	=	77	0 10 57775 587.1			•		
\$	73.75	77	Run (9) 573.75 - 582.1			Recov. = 8.35"		
İ	=	77	Top .25 same tan.					
	=	74	gray L.S. changing to light gray fine		İ	۵. ۳. ه سند سا. الد علا		
	3	74	grained unweath. L.J.					
}	3	77	d 574-576 with	ŀ				
	-	///						
	3	7	few luggs with gray soft shale lenses		- 1			
1		\mathcal{I}	.5 - 1 + thick at tup					
	3	7,	k bottom of that zone			,		
	. =	7	then at 576 - 582.1			•		
	=		back to tamish gray					
	7	7	porous, sw , L.S.	Ī				
	- #	7						
	#	7						
1	=	7						
	82.1	471	Run (10) 582·1-583·9		- 1	•		
٦		//	Source have in the			Run was cut short		
	=	/	Same tannish gray	- 1	1	due to blockege		
	\exists	/ /	L.S. , less porous	[of water circuit.		
	=	/ /	than before		1	Need to replace wit		
	크,	9.583						
-	E					Recos. 1.8'		
	4							
	Ξ							
	=======================================							
	=		A-22					
						HOLE NO.		

шпо	- 600	(Cent 3	(heet)			Hole No. CS-3
a			DISTALLARON			, sen 5 or sens
			CLASSIFICATION OF MATERIALS	% CORE	SAMPLE	MEMARKS (Drilling sime, mater last, depth of
MOITA	DEPTH	HCD-C	(Duripina)	ERY	HO.	weathering, st., if separtical)
•	-	٤				
	- 4=		Run (11) 583.9 - 594			
	583.4	11	RUN (II) SESSION ST			Recov. 10.2'
	=	/_	Tannish gray L.S.	i		•
	_	-	Nonporous, hard,			D.T. = 60 -in
		1,1	unweath. w/ plenty			w.L. = \$
	_	$\mathbb{Z}_{\mathcal{I}}^{\mathcal{I}}$,			
	=	1	of quarte at			
	I Ξ	7-	bottom 2' especially.			
	=	1	Also freq. shale			
	=	//	lanses.			
	=	7,7				
	1 3	$I_{I}I$	Top . s porous.			
	_	1 ,7	•			
		1				
		/				
	3	/				
	-	1				
		//				
		Z, Z]		
	=	1	·			
,	_ =	1		1		
	=	Z,Z,				
	594	11	Run (12) 594 - 604.2			
		7	Same as above			Rew. 10-2'
	=	, ,	getting sw & porous			0.T 30 min.
	Ξ	11	_			
		1/	and sitty vuggy at			w.L. 2 pt
	Ξ	41	600-4 +0 604-5			,
	=	7.7	with weak fetted			
	_	//	ador.			
	=	7	3861.			
	_	127		•		
	1 =	1,-,		1		
	_	12				
	-	4-1-				
	=	,7,		1		
	=	7				
	=	4				
] =	4				
	_	Z-, Z,		ļ		
	=	11		1		
] =	4,		}		
	=	7		1		
	- ۱۱۰۷	1	Run (13) 604.2-614.3			
-	[]	1,1	Same as above.]		Recov. 10.1
] =	11	bosons to clo.3			
	=	//	then less weath 4			D.T. = 30 min
		7,7	non porous to			W. C. = 4
	-	7,7	and of ame			
	3	1,1	A-23			
	1836-	A (ER	l	PROJECT	1	MOLE HO.

	ш	(Cent 3	iheet) MEVASION TOP OF HOL				Hele No.	
MICT				PETALLARON				SHEET C.
			CLASSIFICATION OF	MATERALS	# COSE	SOX OR	10-11-1	MARKS maser has, depth of
MOSTAVI	HTTBE	(EGD40	(Darries		EECOV.	NO.	Drilling and	L, if agraficant)
•	•	5			+ *-			.6
	=	4						
	-	4						
	. =	7						
ı		1,1					,	
- 1	_	1			1			
	=	7						
		4-4						
l	=	ZZ						
.	=	/ '/						
l	7	7			!			
	- =	//					•	
- 1	コ	// /			1			
- [= =	7						
	#	4,4						
- 1	\neg	44						
Į		,7.	.					
Į,	때크	4,4	Pun (14) 614.3	- 616				
	=	11/1	Inner barrel	tan Lib			Recou.	\. T
1	=	1/1	latch & had					
	=	144		(0 00				
	سد غ	77	retreived.					
		10	shaly dark	Iran				
- 1	3	12/2	L.S. , poros		1 1		-	
		1	shale lenses		1 1			
- 1	⇉	20]			
	#	1/2	Run (15) 616-	626-1				
- 1	=	1					Recov- 1	1.0
	3		Dark gray na		1 1		D.T. =	
		11	shaly his o			1		=
	3	11	townish gray	, sing.	1		w. L. = 9	
	\exists	1	porous at 62	1 - 625.3		,		
	#	7	then wen pore	~				
İ	#	1.	•					
ł	7	//	end of core.		1 1			
- 1	7	2/			1 1	j		
ı		7-7	•					
ł	3:	12]			
- 1	_	127				- 1		
1	= = 1′	1-7						
	#					. }		
	7	7						
	7	1.				1		
		1						
	3	1	Run (16) 626.1.	- 636-3				
							w.L. = 90	
	#	/_	626.1 - 628.5	_	j		D.T	₹.
	7.	7	gray ling si	nake.]		Recov. =	10.2
	7	-	Getting pure	shale			Keres	
	Ţ	7	at 628.5 - 6	34.1			D	
تا	::: <u>:</u>	_].	Pres. core !	
	3		635.1 - 636.3	رسنا			627.8 - 6	29.2
	王	-	shele again]	-	629.2-6	30.72
	=	_ †	3			j	631.55 -	432.5
	#					1	634 - 635	-15
	7		•			- 1	635.15 -	636.3
				A-24	. 1	- 1		

MECT		,	heet) sevation for or hou	PISTALLATION			Hole No.	ser 7
EVATION	DEFIN	NGB40	CLASSIFICATION OF	MATERIALS)	# CORE	SOX OR SAMPLE NO.	(Drilling sine, of monthsring, st	AARKS moore face, depth of to, if agmificant)
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	=							
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	_		i		İ			
		- —						
	_				1			
	=							
	=							
					1			
	636-3_		Run (17) 636.3	- 639.43				
		14	Dark greenish	ayan			_	
	. 7	44				1	Pres. Con	
	7	7/1/	shale (limy) ~			636.3 -	<u>438-\</u>
i	7	ŹΖ	top .4 grad	ing to			£ 26. 2 =	·
	∃	17						
	7	44	shaly L.s.	# fo				
	. 3	-//	tannish gray	٧.5.				
	639.4	17						
l	=		@ 638.1 - be	- 170				
I	=	I						
1	=	Ì						
Į	⇉		BOH 63	9.45				
	ᅼ	ļ						•
	لساسا							• •
J	=	İ						
	=							
	3							
1	\exists	Ì						
Į	П							
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1	⇉							
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ļ	4		•			.		
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	\exists							
	7	- 1		A-25	1			

C5-4 Hele No. HEET \ OF 7 SHEETS DRILLING LOG H. HIZE AND TYPE OF SIT NO WITE PROJECT UTP LOCATION (C 12. MANUPACTURER'S DESIGNATION OF ORICE B-CFI. Knox , KY FMSM UNDISTURBED 12. TOTAL NO. OF OVER-HOLE NO. (A. C5-4 14. TOTAL HUMBER CORE BOXES MAME OF DRILLER John Serber IL ELEVATION GROUND WATER L DIRECTION OF HOLE M. DATE HOLE Dec. 16,92 DEG. FROM VERT DVERTICAL | INCLINED 17. ELEVATION TOP OF HOLE THICKNESS OF OVERBURDEN 16. TOTAL CORE RECOVERY FOR BORING 144.65 DEPTH DRILLED WITO ROCK 19. SIGNATURE OF INSPECTOR Alsayab 9. TOTAL DEPTH OF HOLE 643-85 S CORE BOX OR SAMPLE MO. REMARKS no, major loca, de d, ota., II algolitic CLASSIFICATION OF MATERIALS ELEVATION DEPTH LEGEND Hole pre dilled to 499.2' & cased to 95' 2-pth RUN (1) 499.2 - 505.3 Dark brown New Albam Recov. shale with gray D.T. = 35 min w. L. = 100 % hues . Two soft gray clay Pres. core: Zones @ 499.4-499.5 501.45- 502.2 502.2 - 503.05 and 499.6-499.9 503.8 - 504.6 Run (2) 505.3 - 515.3 505.3 Recov. 10 New Albany shale W.L. = 50 % w/ Pyrite lenses 4 0.T. = 60 min 1" thick pyrite interbed @ 506.6 Started loosing water at 310 depth . Pres. core : 507.5 - 508.45 509.4 - 510.3 511.15 - 512.4 512.7 - 513.3 514.1 - 514.7 3 **A-27**

	LOG	(Cont :	Sheet) REVARION FOR OF HOLE			Hole No. C5-4	_
3.0007			DETAILATEN			Ch helis beti S	
EVATION	DEFTH	uice-o	CLASSIFICATION OF MATERIALS	% CORE	SAMPLE	(Drilling time, mater law, death of	
		,	(Description)	CATY	HO.	(Drilling sime, masor last, deput of manthering, star, if significant)	
•	-			 	·		
	3		0 (2) 5/5/2 5/5/2				
	515.3		Run (3) 5/5-3 - 525.3				┥
	=		515-3 - 520			Recov. 9.9'	
	=		New Albany shale.			D -4 - 6 1	ŀ
	l 3		Dork brown, thinly			Pres. com:	-
	ゴ		haminaled, umwechh.			516.23-517.45	
			with pyrite lenses.			518.3 - 518.9	ŀ
	ヨ		520 - 525.3 : 4.5.	1 1		518.4- 519.8	E
	╡		light gray , unweath.	1 1		519.8 - 520.8	þ
	=						F
	\exists		with fetted odor.	1 1		0.T. = 40 min	E
- 1	520	, ,	L.s. is perous @	.			Ė
	크	4	520-522 .	1 1		w.L. = 100 %	F
	= =	-/				•	F
		4		1 1			E
- 1	3						-
j			•				þ
	=						E
	\equiv	77	•		ŀ		E
- 1	=	74			1		þ
	7	// /			- 1		E
	- 1'	7-4			[E
L	25.3	77	PUN (4) 525.3 - 835.5				þ
ľ	E	77	525.3 - 527.9 light			0	E
	=	77	gray L.S., was parous,		- 1	Pres. Love:	E
	=	7	-			530.55 - 531.4	F
1	\equiv	/ / \	mod. coarse grained.			532.8 - 534.6	E
	=	/	changing to darker gray		- 1	534.6 - 535.5	E
1	= 17	7	Shaly L.S., unweath,				F
1	-] -		mod. hard, to better		İ		E
- 1	. =	1/	of core.				E
l		1	•				F
- 1	3	//		' I		D-T. = 30 min	F
	=======================================	7		1		W. L. = 100 %	E
	#	101		- 1		_	E
	_=-	1/1				Recovery = 10.2	F
	3	1.1	·		- 1		E
	∃7	7					E
- 1	7	7	. 1	.			F
	- 3 7	7		1			F
	-]	I					E
	北		ļ				F
	-	//,			1		F
	37	4		- [1		E
Į,	5-3	V/ E	UN (5) 535.5-545.5				E
P		L	Same L.S. as at			D.T. = 50 min	F
	_ = Z						F
	34	/	bottom of last run,			w.L. = 10= %	F
	3/	4	Shaly.			Recov. lo'.	E
	7/2	1				· · · · · · · · · · · · · · · · · ·	F
	#		A-28	1			F
	/	1/	A-20	10,807			L

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10		-	heat) REVANDH TOP OF HOLE	DISTALLATION			Hole No. C5-4
ATION	реги	ulcano C	CLASSIFICATION OF		% CORE	BOX OR SAMPLE HO,	(Drilling sime, mater lam, depth of weathering, one, if against
<u>•</u>	=	is					
	<u> </u>	14					Pres. core:
	- =	11					535.85-537.05
]	4					531.05 - 538
	=	471					538 - 539.2
	Ξ	///					542-9 - 544.1
		11	•	,			
	-	1,1					•
		1					
	=	1/1					
		///					
	1 =	//_/	•				
	545.5		RUN (6) 545.5-	555-7			
		11	Top foot gray				Recou. 10.2
	Ξ	14	L.s. gradin				D.T 20 min
	=	17	It. gray pore				w.L. = 100 %
	3	//	with fetted	odor.			
		1	Andda + 211/2	. weath.			Pres. core:
	-	4	More vuggy @	551.6- 55			
	=	44	770				545.5 - 547
	=	1			1		
		1-1					
	=	1			1		,
	Ξ	/			1		
		4					
	=	7-1			1		
	Ξ	1					
	Ξ	7					
	=				İ		• •
	Ξ	4	_				
	=	4					
	555-T	-/-	Rem (7) 555.1	- 565.8	<u> </u>		
		4	555-7- 551				. Recou 10-1'
	-	4,-	busons ' nadda				D.T. # 20
	=	Ź 7	with felled .		-		W. L. = 100 %
		\mathcal{I}	more shally &	less to	non		
		4	porous - w	ith darke	5		
	=	/-/	gray color 5	57-562		1	
] =	11	At SLE L.S.	gets			
		77	silly weath,	-			
] =	44	gray & poron				
	=	1	strong odor.			1	•
] =	77	21.5.7				
	=	///		A 00			
	=	1-,-		A-29			

MORG					DISTALLATION				SHIELD
						-			Cr 240
				ASSINGATION	OF MATERIALS	% COM	BOX OF	25144	
ELEVATION	DEFTH	MCD-ID	l ' '		(inin)	SECOV-	SAMPLE MO.	(Drilling time, was	محدد خصر المحاود أن
	b	•			<u> </u>	-	7		
	-	1//							
	_	1'/-	t			1]		
1	-	///					1	1	
	_	 -/ 				.		1	
	=	1//					1		
ŀ	_	//					1	1	
l	-	/ /				1	1		
	=	7				1	ľ		
. 1	565.8	7	Run	(8) 54	5.8 - 576	1	1		
	563.0	7							
	_	4-7-	565-B	_ 567.4	porous			D.T	5
	_	144	1				1		_
	=		7000000	2,00	7 2.5.	1	1	W. L. = 104	7.
ļ	=	/ 7	SW,	gettime	y mwent		1	j	
		'/ '/			then sw	ļ		Recov. 10.	.2
- 1		4				- 1			
l	-	44	عيمن	- to 6	thom of c	-14			
į			0400	•					
- 1	╛	17				1			
	_ ∃	77							
- 1		7-7]		
- 1	∃	4,4				1			
ļ	ⅎ								
i		_/_/				1			
1	=								
1	=	1/							
ļ	-	'/'					}		
- 1	3	///							
- 1	7	4				1			
1	\neg	44							
	ⅎ	1 1							
- 1	=	/ /				Ī			
- 1	=	7-4							
1	_					1			
1	=	- ' - '						•	
ļ	7	7/7			•				
	ᅠ그	4-4	0 10) 574	- 501				
-	576 J	/-/	KUN (7	, 5/8	- 386				
- [Ⅎ.	4,4	Too	s' L.	mish gray]	D.T. = 20	mis.
- 1	그.	/·							
	7		pered		٠, ٥٣, ٦			w.L 100	*/ <u>-</u>
. 1	Ξ	/_/					ŀ		,
1	-5	, ,			rec dram.			Recov. 10	-
- 1	∃.	7 7	Shalm	wo	4. carse		1		
	Ξ.				6-5 - 578-	- I	Ī		
1	7	/ /							
}		// /	where	It ha	s 1° Hhide	.			
							- 1		
	\neg	7			7.8Fc				
	#	,		576. S	alead)				
	/				د خسس ی				
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	-7'	7 / 1					J		
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1		7-4					ľ	* Maxt day	, tobs
	-7-							where hum	2 mp =
- 1	7-					- [@ 486' and	لاست ا
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ł		//-					- 1	. ~~~ 4	_
	7	77					l		_ \
		, ', ' ,					- 1	Flushed hal	
- 1		4,4						inserting v	peter /
1	7						- }	ها سامع عاد	3 M , WI
ı	77	7			•			soap & bent	a siima
		7				1	- 1	Took 2 days	
L.	26 -				- V-3U -				
5	a6 🛨	1	***		- A -3 0 -				·

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		Cent 3	heet) REVARION FOR OF HOLE			Hole No. C5-4
CT .						OF SHEETIS
ATION	DEPTH	ricesio	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV- ERY e	BOX OR SAMPLE HO.	REMARIS (Drilling since water law, depth of washering, str., if significant) E
	=	,				
	584 -		Run (10) 586 - 596.2			Dec 21, 42
		ZZ	gray to tamish gray			stuck on wood.
	=	4,	L.S. with leases of			Freed on Fri
	ΙΞ	7.4	soft gray shalle.			Resumed coring on
		7	Non porous, unweith.			Hon. Drc. 21, 92
] =	7	with quartz.			Using Revert mud
		/ /	Smooth texture.			
		//	Smith deviate:			D-T. = 45 min.
	=	///				W.L. = 100 %
	=	171				Recov. 10.2
]					Kecos. 10. 2
	=	4				•
	\exists	///	•			
		7-4				
	3	7				
		$\mathcal{I}\mathcal{I}$				
	\exists	4				
	-	+				
	Ξ	7				
	-					
	=	4				•
	596.2	// /	Run (11) 596-2-606-4			
	=	44	596.2 - 602.5 Same			D-T- = 50 min.
	-	1.	L.S. as above, smooth			W.L. = 100 %
	=	1/	textured.			Recov. 9.95 on
	\exists	II	At 602.5 core gets			Recov. 9.95 on
	=	44	tannish gray . Rock			(0.2)
	=	4	gets vuggy @ 603.5-			
- 1	=	-/-/4	605 4 porous 605-			
	\exists	Z'Z	bottom .			
	=					•
	_	11	2 broken rock zones			•
]	44	where rod dropped			
	=	4-4	while coring at			
	目	17	4 11 5			
	三	47	•			
	=	44	605.3 - 605.5			
	=	1.	where unggs caused			
	=	7 / /	rock to break.			
	_ =	7				
	=	/ /				
	=	$\mathcal{L}\mathcal{L}$				
1	(aL - W					4
	=					
	=	Į			.	
	I					, ,
]		A-31	'		
ORM			701	PROJECT		HQUE NO.

O.RCT		,	Sheet) SEVATION TOP OF HOLE			Hole No. CS-4
LEVATION	ретн	ricas-co	CLASSIFICATION OF MATERIALS (Dumping)	% CORE	SOI OR SAMPLE HO.	(Drilling time, mater late, depth of mathema, att., if separate)
-	=		•	-		·
	66.4	, , ,	Run (12) LOC-4- CIL-T			
	=	1/1	Light tamish gray			D.T. = 50 min
		$I_{\downarrow}I$	L.S., weath.,			w.L. = 100 %
	∄	-/-	bosons & n-222 mith			Recov. 10.2
	크	-'-'	fetted odor.			
	₫	$I_{\perp}I_{\parallel}$	Changing color @ 614			
	=	1 /	to coment gray , more			
	크	$I_{\mu}I_{\mu}$	porous 1 conver graine	`	1	
1	3	4-4	Deteriorated rock		İ	
	寸	7 / /	Zone @ 612.6-612.8		.	
	=	1		1		
	7	4-4		- 1	1	
.	. =	LT				
	4	//				
	土	T		j		
	= /	\Box				
	3	7-4				•
	3		0 (12) (1) 7 (2) 85			•
اع	47	/ /	Run (13) 616.7- 626.85		-+	P 17 2 '
	挈	7	616.7 - 629.3 Same L.S. as at bottom of			Recov. 10-2
	3	///	previous run (coment			w.L. = 100 %
	=	7.7	gray , perous)	- 1		D.T. ='35 min
	1	44	629.3 - bottom : gets			
	<u></u>	// /	shaly, with thin			
	团		Ramination, tannish	1	1	
	٦,		gray L.S.		ĺ	
	*	//	plenty of gray shale	.		
j	3,	7	lenses.			
		7			İ	
	===	7-4				
İ	===	Z /				
	==	7			ļ	
				ŀ		
	∃-	44				·
	1	7				<u>.</u>
	25	//	Pun (14) 626.85 - 636.85			·
(2)	1		626.85-650 tamish	-	-	D.T. = 95 min
	34	-	gray, non parous Lis.	1		w L. € 100 %
	並		Trading to sarker deat			Recov. q.q'
	4	, ,	shally his. to 632		-	1.5000. H.H
	工		A-32			Ė
ORM 18			A-JZ			-

LLING	LOG	(Cent S	heet) MAYATON TOP OF HOLE			Hole No. CS -4
ect			DISTALLATION			SHEFT TO SHEETS
			CLASSIFICATION OF MATERIALS	% CORE	BOX OR	PEMARKS
VATION	DEFTH	(ECD40	(Description)	ERY	NO.	(Drilling sime, water lan, depth of weathering, stee, if againsant)
•	-	-		•	-	
	=	7	Then grades to #			Pres. Core:
	=	-/-	greenish gray shale			
		Z'Z	(waldron), thinky			
	632	1	laminated & .fine			
•]		textured to end			
•			of core (i.e.	1		
	=		632 where shale			
	=		storts)			
]		3.5.(5)	1		
	ΙΞ					
	=		•			
	ヒー			1		
	=	—-				
_	(36.85		Run (15) 636.85 - 643.85			
_	=		Shale (waldron)			Recov. = 7'
	=		as in bottom of			
	=		previous run changing			w. L. = 100 %
	=			Y		D.T?
	E		to tannish gray			•
	=		L.S. at 641.5			Pres. core:
	\equiv		639 - 640.5 Shale 4			~~~
			L.s. mix.			
	64.5		L.3. W.X.			
	64.3 <u>=</u>	//	•			
	=	$Z_{\mathcal{A}}$				ě
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FORM		1	A-33			

BU				_	rume			-		stalled 7
Project Date: 9	tert	UTP 5 1/9/ 93 Complete =6 /8/ 93			lace um fi				-	7041' 3
Location Drilling Driller _	Age Tec	Still I Inspector Legges	z					E	3 1088	
Drill II Drill M Thickne	Drill Type Failing Hole Master CF-13 Drill Method 174" Lit, 174 Lit, 24" Care Thickness of Overburden 35.6" Depth Drilled Into Rock 609,7"				Map	MBER	PE	CONTENT	TER-FLUIL	LABORATORY RESULTS AND REMARKS
Total D	epth	of Boring 645.5'	CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	E R	ET	URE	/AQ	
ELEV.		ng_X_vertinclinedDeg SOIL CLASSIFICATION	USCS	100	ECO	AMPL	AMPI	OIST	DQ.	
701,112	DEPTH	SOIL CLASSIFICATION 4.9	7	60	Œ	8	8	=	ō	
-		Brown, CLAYEYSILT,								1 1/4 " Tricone Roller :
	/ -	Moist, Soft to Medium Stiff (0-37)	mL							Bit to a dipth of
- 1941/±	2									Installed 6" Sch 80 -
	<i>7</i>	Reddish Promoto Brownish Red, CLAY, Moist to Dompo Medium Stiff (3'-5')	CH.					-		47ft, The cosing fell 215 when started
C96.12	=		i							To use 434" Hamase -
•]	Red to Ruddish Brown,	CH						1	extension on to P.K.C.
	/ =	Cherty <u>CLAY</u> , Damp to Dry, Med Stiff to								Casing
	74	Medium Stiff								Oupto of 6"P.4C. Casing 49.5" m/
	4	(5'-24.8')								1'Stickup
	1						۱			, , ,
	9 = 3						1			7
_	10									24" Core
	,,,	•							1	
	3		.	l					1	Core Borrel
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2	e I									
MBOLS:	₹.	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	LETIO	N				>	> -	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

SHEET ___ OF 33 . A-35

Project	<u> </u>		urfa					-					
Location NE			Datum for S										
	- [T	7	_	T	T	T	_					
Drilling Agency	_						=	1088					
Driller inspector	-	<u>ج</u> ا	- 1				E	5					
Drill Type	-	Ĕij	=		l		토	13	LABORATORY RESULTS				
Drill Method	-	5	<u>ا</u> ع	0	监	L	E	뜻	AND				
Thickness of Overburden	-	911	4	ğ	9	ם	CONTEN	Ė	REMARKS				
Total Depth of Boring	- 3	2 1	RECOVERY/ROD	ا≩	3	TYPE	<u> </u>	Ş					
Dir. of BoringVertInclined De	- 3	5 9		VE	4	4	5	9					
	<u>'</u>	BIOWR DED - MOST	5	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE	MOISTU	3					
a Join Grant Marion		5 2	4	2	8	8	ĭ	GROU					
SURFACE COVER			\perp										
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L 27]		1	1	- 1	1	1							
E 173	1			- 1			1						
E 3		1	1			1		1					
E 44-1		1				1	1						
E	1	1	1	1	1	1							
25 Light Red, Fine SAWDY CLAY 24 W/ Leases of CLAYEY FiarSAM Dump to Moist Soft to		_	1	-	1		1						
Light Red, Fine SANDY CLAY	1			1									
WILL SILVEY EL CAR	ر. ام		1										
21- 4/ Linger of CLN/E/ Fraesmir	44		1		1	1	Т						
Damp to Moist Soft to	156	•	1	1		1	Ī	1					
med Stiff			[1	1	1						
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(24.8'-35.8')	1	1 1		1		ı							
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SHALE, Light Brown to	- 1		- [1			4				
Lt Gray, Soft to Mod Hond.	- 1			ı			1		1				
SHALE, Light Brown to Lt Gray, Soft to Mod. Hord, Weathersd, Damp on/ CLAY		- 1	1	1		1			4				
H 3 Weathered, Domp on CLAY		- 1					1		7				
1 4 384.014	ı			1					4				
(35A 7062')		-	1						4				
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39 - New Providence Shale	- 1			1					. 4				
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IBOLS: WATER LEVEL AT COMPLETION			-	_	_	_	Ĺ	D.	APTAL LOSS OF THE				
WATER LEVEL HOURS AFTER COME	LETTO	N				`)-)-	7	ARTIAL LOSS OF DRILL FLUID OTAL LOSS OF DRILL FLUID				
FORM 1202 ne 1988 SHEET 2 OF 33 s A-				21					LOGG OF DRILL PLUID				

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RO			U. -	<u> </u>			instr Surfi						stalled
Project		11	Compl	- / /			Datu	ım fe	X S	Suri	ec.	E	7
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		су								Н		1088	
Driller _	, . 		Inspecto	r		Z							
						≥	I			H	퇴	킼	LABORATORY RESULTS
Drill M						გ	일		岳		삐	뙤	AND
		f Overburg	den			ı E	I	ğ	9	W	ğ	삗	REMARKS
		into Roci				8	5	₹	Ę	Σ	9	≨ l	
Total De	epth	of Boring_				ರ	8	3	щ	쁴	5	貟	
		ngVe	vrt	Inclined	_Deg ·	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	A	H	8	GROUNDWATER-FLUID	
ELEV.	рертн			SSIFICATION		5	百	E	8	SAMPLE TYPE	Ĭ	티	
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651.6	75-									4		- [Bottom of 6 4 P.V.C. 5/20
-	E												Sch 80 Coslag Etu 651.6'
	50											-	Eku 651.6"
434	=									-			at 49.5 Changed to
- I	5/=									1		- [WI TTIS CHANGER 10
- ''	7												434" air hammer drill bit
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YMBOLS	: <u>V</u>	WATER L	EVEL AT	COMPLETION								>	- PARTIAL LOSS OF DRILL FLUID

SHEET 7 OF 33 A-37

BO		IG NO		Instr Surfi						stalled
Project	_	U. T. P. / / Complete/ /		Sum						3
Date:St	art _	E				Г	Ī	-	-	
		ncy	ŀ					5	1088	
Driller_	7.90	Inspector	Z					151	-	
	ype_		Ĕ	天				됢	3	LABORATORY RESULTS
Drill M	lethoo		2	Į ž	۾	띭		틸	Ē	AND
Thickne	35 0	Overburden	38	E E	Ĕ	3	1	8	Y	REMARKS
		into Rockaf Boring	💆	PE	E	2	1	뿔	š	
Dir. of	Borii	ngVertinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERYMOD	3	弖	ST	GROUNDWATER-FLUID	
ELEV.		SOIL CLASSIFICATION	85	E E	置	8	8	MOISTURE CONTENT	GHO	
64/1/=	DEPTH	SURFACE COVER								
<i>- 1111</i>	66 -									5/2/
SH		-			Ì		1			•
_)//	61-									
יו מני	1 3	To of 110 menthered Rock			1			Н		
639.1	62-									
	:	STALE, LIGHT MOD HON,								
5 H	63-	Too of Homesthered Rock 5th ALE, Lt broyg Mad Hond, Mamsothered, Org. (62'- 439')						Į į		•
. J /T	:	(6)-4397						1		
-	64-									•
		New Providence Shale								•
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MBOL	s: ∑	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COM	401 ET	701					. :	- PARTIAL LOSS OF DRILL FLUI - TOTAL LOSS OF DRILL FLUID

SHEET 4 OF 33 SHEE A-38

	" 70			rume					stalled
Project	(/, /, //, _/Complete/_/			ace					
Date:Start _	/ Complete/		Deta	um f	or (SUI	-	_	J
			1			1		88	D
Drilling Age	ncy					1	3	GROUNDWATER-FLUID LOSS	•
Driller	Inspector	Z				1	5	₽	
Drill Type_		USCS CLASSIFICATION	天				MOISTURE CONTENT (3	LABORATORY RESULTS
Drill Metho	d	1 2	12		5		Ę	늝	AND
	of Overburden	F.	4	S.	9	H	Ñ	1	REMARKS
Depth Drille	d Into Rock	Ass	BLOWS PER 6-INCH	RECOVERY/ROD	夏	Ξ	Ę.	1	
Total Depth	of Boring	1 8	6	E	щ	щ	5	ē	
	ingVertinclinedDeg	2	I ₹	Į	€	Ē	13	Ş	
ELEV.	SOIL CLASSIFICATION] Š	1 \(\frac{1}{2} \)	層	3	3	皇	E	
ELEV. #	SURFACE COVER	+-	-	-		-		Ť	
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SYMBOLS: V	WATER LEVEL AT COMPLETION							>	- PARTIAL LOSS OF DRILL FLUID
₩	- WATER LEVEL HOURS AFTER COM	(PLETI	ON				,	١Ś	- TOTAL LOSS OF DRILL FLUID

SHEET 5 OF 33 SI A-39

BORING NO. 65-5

BOI	KIL	NG NO25-5								stalled
Project		"U, T, P 			lace um fi					8
Location	27	E		T	T	Ī	$\tilde{\Gamma}$	_	_	
Drilling	Ane	NCY					1	_	8	
Driller	Ayu	inspector	z	1				$ \mathfrak{E} $		
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SHEET & OF 33 SH A-40

BORING NO. 55-5

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MBOLS		WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER CO	OMBI ET	ION						- PARTIAL LOSS OF DRILL FLUID

SHEET 7 OF 33 . A-41

BORING NO. <u>25-5</u>

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YMBOLS:	∑ w	ATER	LEVEL !	AT COM	PLETION								> -	- PARTIAL LOSS OF DRILL FLUID
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SHEET _______ OF 33 SI A-42

BORING NO. 25-5

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SHEET 9 OF 33 S A-43

BORING NO. 555

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BORING NO. 25-5

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SHEET // OF 33 : A-45

BORING NO. C5-5

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SHEET 12 OF 37 SHI A-46

>> - TOTAL LOSS OF DRILL FLUID

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	WATER LEVEL _	HOURS AFTER	COMP	LETIO	N			•	۲,	PARTIAL LOSS OF DRILL FLUID

SHEET _/2 OF 33 : A-47

BORING NO. 05-5

Project	Proje	DRII ea	VG	NO.	T.P.	15-5		Sun	face	Ele	WZ.	tior		stalled
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SHEET 17 OF 33 St A-48

>> - TOTAL LOSS OF DRILL FLUID
BORING NO. _ 5-5

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SHEET /5 OF 33 S. A-49

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SHEET 16 OF 37 St. A-50

>> - TOTAL LOSS OF DRILL FLUID
BORING NO. <u>\$\sigma 5 - 5\$</u>

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1 June 1988

SHEET 17 OF 33 A-51

BORING NO. 25-5

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SHEET 18 OF 33 St A-52

BORING NO. CS-5

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	*	WATER LEVEL H	OURS AFTER COM	PLETIC	NC				>	5 -	TOTAL LOSS OF DRILL FLUID

SHEET 19 OF 33 S. A-53

BORING NO. _c5-5

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SHEET 20 OF 33 SH A-54

BORING NO. (5-5

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SHEET 22 OF 33 SH_ A-56

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Drill T	ype_						5	3	į	_		3	1	LABORATORY RESULTS
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MBOL	5: V		R LEVEL		PLETION									- PARTIAL LOSS OF DRILL FLUID

SHEET 23 OF 33 A-57

>>- TOTAL LOSS OF DRILL FLUID

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Total D	epth (of Boring.				7	-	5	w w		5	õ	
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SHEET 27 OF 33 S. A-58

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Driller _		Inspector	7	1		1	1.	 •		
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Thickne	33 0	f Overburden	Ē	I	Įğ	1	ш	ĮŠ	臣	REMARKS
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SHEET 25 OF 37 A-59

>> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

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iii Type	USCS CLASSIFICATION	I_	1	ı	SAMPLE TYPE	E	GROUNDWATER-FLUID	
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SHEET 26 OF 33 SI A-60

BORING NO. <u>(5-5</u>

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		f Overburden	윤	M		留		E	E	AND
			8	2	E	3	1	8	匮	REMARKS
•		I into Rock	3		≥	Z	F	끭	I≩	
Die of S	Pode	of BoringinclinedDeg	JBCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	ᄬ	۳	MOISTURE CONTENT	AROUNDWATER-FLUID	
		79	2	6	8	3		8	10	
LEV.	DEPTH	SOIL CLASSIFICATION	5	표	22	8	8	ĭ	등	
181.12		SURFACE COVER								
1	20.					_	П		П	
	- 1			l ,		W.			1	
.	2/4	•	•			0				
ľ	~ 1	·				M	П			
		•				3	Ιl		П	
· 5	깯						H			
	3	- Stole Laminax BIP					۱, ا			
ء ا	<u> </u>	/				-	4]			
ľ	77	-					1			Run 5
	7	1					'			
. 5	2/-	- Mech 6-co								Cored 10.3
	4	1								Rec 10, 3
·	1,	1100 4 10141 4	į				١	ı		1176 1013
P-	′ ′′≒	Lines tone, Light Gray to Gray, Medium Hard to Hard, 5 lightly Vuggy, W/ Paraus Zones, Styiolites, W/ Occ Shale Laminas or								Loss 0.0
		Grave Medium Hard to Hard.					- 1		1	
12	24	5 Hehth Vinger to Vicery			l		ı	- 1	1	Time 12:35-13:10
	4	7 1771119 0 479 9 10 10777					- 1	ı		
	_ =	w/ Parous Zones, Stylolites,				1	1			
Ls 15	27-]	wellow Shale landage or	I			- 1	- 1			
-	3	A /				- 1	- 1			
10	*	na.	1		l	- [- [
ľ	7	- Mech 6-10	ĺ	Į			- 1	-	- 1	
1	7			ı	0		١	- 1		
12	29-7				1		4	- 1		• •
1	- 4			ı		.1	- 1	- [- 1	
5	٦,,	1		- 1	20	- 1	- [- 1		•
l,	"=		l		0	- 1	ł	- 1	- 1	
	7			J	0			ı	- 1	•
b	7 /	1		- 1	7		- 1			
	4			- 1	- 1	- 1	- [- 1	- 1	
- _	.,‡	-Mech	- 1		.					•
23	~ -		- 1	- 1		-	-1			
	4		l							
, 53	7		- 1		ı				I	
L5 13	=	Mich	- 1	1	\dashv				F	0
	F	Mach Gio	ł							Run 6
13	"子	THEER VE	·	- 1			1			Cored 10,2
	3								-	Rec 10. 2
53	35-				- [1			
"	7	1	- 1				1		-	LO51 0.0
ı	7		- 1	- 1		ĺ	1	-	1	- 1
53.	7	1						-		Time 12:55-13:20
	4	, .			13				1	
۔ اے	, 4	′ 1			0				1	
27,	イ	1		1	1			1		
	4	- 1		.	7					
3	٢,	eu, i am		- [1			1	1	
Γ.	<u>+</u>	SH Laminax BIP Mech SH Bodding	- 1	- 1	','	1				
	3			- [.	8			1	1	
13	汗	-SHLARIARZBIP Planz Moch for	1	I,	${}^{\prime}$	7		1		
İ	41	-SH Laming - Zone BIP	- 1		200	<i>:</i>	-	- [
Eu	"X	- Comented Tt	- [Ž	1			1	
									1	

1 June 1988

SHEET 270F 33 A-61

BORING NO/_	Instrumentation Installed								
Project					_				
Date:Start/Complete/_		Date	an I	or i	ou/	IEC			
Location NE	1	1		-		ı	8		
Drilling Agency	1	1			1	3	1088		
Driller inspector	3	1	ĺ			5			
Drill Type	Ĕ	五	l	ı	1	Ξ		LABORATORY RESULTS	
Drill Method	5.	12		5		E	띳	AND	
Thickness of Overburden	Ē.	1	ğ	9	ш	8	5	REMARKS	
Depth Drilled into Rock	88	5	5	15	5	0	3	· Land	
Total Depth of Boring	\$	<u>a</u>	5	Z	-	Ē	췸		
Dir. of BoringVertinclinedDeg	8	8	3	1	2	E	3		
	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	₹	SAMPLE TYPE	MOISTUR	8		
<u> </u>	3	-	=	8	8	3	9		
SURFACE COVER			-	Н	Н	\dashv	-	2 1 1 1	
- 160.6	i			П	ı	ı		Ran 6 out of spre	
1000 Elei 1606-1596								for core size	
F 1"4					ا را	ı			
1 + vu1		.			4	- 1			
159.50					4				
[]					٠ ا		Į		
- Solation Mech					- 1	1	Ī		
- 1 - Mean					1		- 1		
LS Solution Port]	- [L		
SIR Opin Books					ı	- 1	-1.	Run 7	
Solation					- 1	- [-	Cored 10.3'	
		1	- 1		- 1	- 1	-	Corea 10, 3	
Solution Sty Vertical Freeture	•		ĺ		Ų	- [-	Rec 11,3'	
INTELL DASA				1	- 1	-1	-		
Seletion Sty	- 1				- [- 1	Loss 0.0°	
- 61P Day	- 1		- 1		- 1	- [-	Time 13:40-14:45	
12.0			ı				- 1	Water Return 370	
V. Porous Elev	1	- 1	- 1	1			1		
577 - BIP Open 155.6- 152.8'	Í	- [1	l			-	
3 4/04	ł	ı	ı		I				
150.81 STT - Much		- 1			İ		1		
15218 Much	j		6	+		-	-		
I-BIP Open Calutina	1		2	1			1		
BIP Down Solution	- 1		. "	- 1	4		Į		
(6° J+	- 1	- 1	V	\cdot			1		
570 - 571/20/00 005' 200000	- 1	1	10	- [1			Outof Spec Core Size	
	- 1				1	1		UNIUT SPEC CONCINE	
BIP Meah		ı	100	Į			1		
SSI - Open Vess Solution			1	1			1		
They pale some sign	.			ı					
h 1	1	ı		1		1			
SHLamine = BP	- 1	- 1		1					
WEST SHLOWING BIP	-	ı		1	1				
		1		1			Ţ		
Sty of the Live									
147.3' 3-147.3'									
TY OIP Mech		٦	\dashv		1			Pun 8	
1									
SHLAMINAL BIP								Cored 10.0'	
133 - Tominae 13 fr								Rec 10.0'	
1	- 1	- 1	1.		1			Los; 0.0°	
155C = 5 ty		- 1	-		1		1		
SSC Sty SHLomina + BIP		- 1.		1				Time 15:05-15:42	
Open Vag w/ Xstol	ļ	-13	2	1				- 7,77,72	
57- St.				1	1.		1		
Sty Conented BAP	-1	- 1.2	2					1. +. C	
1 -4	- 1	1	ı				1 4	Outof Spec Core Size	
558 - Solution BIP Mech 600		-		1	1	1			
Much 600	1	1.	JA.	1			1	Lost all drill water	
ion Parons		18	98				•		
Sty Meedow SHLamina & BIP		1.3	01	1			Ι′	for rest of Boring	
		1 5	11/	. [F	1	1	•	
Sto Sty meedoco SHLamia es BIP	- [ζÞ	1	1	1	1		

SHEET 25 OF 33 SH A-62

>> - TOTAL LOSS OF DRILL FLUID

BOF		ıu	NO.		5-5		Instr Surfi						stalled
Project							Date			-			9
Location				E	1 .		T	T	1	T			
Drilling a							ı	1	1	1	_	1088	•
_	Agen	icy	lane	ector		-		ĺ	ı	1	13	1_1	
Driller			insp	ector		₫	l_	1	ı	1	E	FUID	
	pe_					7	동	1	۳.		面	12	LABORATORY RESULTS
Drill Me						문	폭	유	I		둦	TER	AND
Thicknes						8	-	ΙĔ		12	18		REMARKS
Depth D						₹		≥	z	15	2	3	
Total De				Inclin	ed Dea	ರ	9	=	빌	쁘	15	밀	
Dir. of		70	.vert		2000	JSCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	불		18	8	
ELEV.	EPTH		SOIL	CLASSIFIC	CATION	5	표	뿐	8	SAMPLE TYPE	Ħ	GRO	
141,12	0		SI	JRFACE C	OVER				Г				
-	560	-SHL	miner !	BIP				Г	Г	П	Г		
: 1	- 1	_5400				i		l		l	l		
- 1	8/J				•		ı	l					
: [1	-544						1	l	12	1		
:		- 146	-SHLAA	ning & BIF	•					12	ı	П	
- 1	562	244				1				4		П	
:	3	-57740 -5740	MILLE B	<i>)</i>						ľ			
	2,3		H Lamia	810						1		H	
137,81	~ 3	SHOO		, L		1							
:	3	200											
136.80	56Y_]	Fre	ctare	Coment	d	1	l						Run 9
	3					[Н	Cored 10,3'
<u>.</u> 1	Z5_	SHO.	OZ' Med	:h '								H	
: [7					1	Į						Rec 10.3
	3	15	4 Lamin	4 + A IP									Loss 0.0
<u> </u>	~/]								Ì			П	•
: [7					1				ı	1	Н	Time
:	z2]	- 5H LA	mina z l	9/0		ĺ		٠.			l.	П	16:05-16:43
- r	"7		Pa	rous E	4.0		1 1				ľ	H	16.05-16.73
: 1	7			7.8'-130									
-65	68		/ >	110 / 34		l							Octected
-	7		,							1 1			
: [25-3	-Core	PIA			•				1			H25 Elev 132,1'
- 1	*77							66					•
	- 7	-Core	5pin	•			1 1	7	•				
- 4	72							0,					•
	₹	_1001	د. عسر بد	171			li						
L	Εĸ	-bus	mented	<i>J</i> 7									
- r	7 7	_SH						11					•
:	- 7		PTA Sol	40.									
- 3	72-			7.00				100			- 1		-
	Ŧ	- Core s	רויים				l	7			- 1	- 1	
١,	<u>Ε</u> κ	Δ.	1600								ı	1	
- r	″∓		n -10					-			- 1		•
	F	_8 180	on Sola	tion	•			-	- 1		١		
127,00	7/	- 11.0	- Mech	, , , ,					١			L	3/28 -
	₹	-5 H	-						-			ſ	Ran 10 6/2
_	" ‡			erz BAP			-		ł			1	Cored 10.3 .
- ! '	"十		ora Sola			.		1	1		- [
. 1	1	-SHL	miage !	SIP	i	1		- [٠١		-		Rec 10.3
- þ	74	SHI	aniant	810			- 1		١				Loss 0.0 -
- 1	- Ŧ	-015		0.	-, I			2			- [*
	E			Porous	Ely	ļ		2			-1		Tine
ľ	77	_ 01 cch	bee.	1270-1	127.91		- 1	9	- [- [-		•
[Ŧ	_ Mech		•				- [-				8:05-8:50
127.91 5	¥-‡	- Mesa 4 -54002						\t	B	-			
	7	-3 9 VW 1	•		Į	l	- 1	10	1		- [-[;
	,,1					l		0	1		1		
· ' ' '	77					ł	Į	00	•				-
- 1	4	-5 H 0,01	, –		- 1						J	-	
	103	2 17 0,01			<u> </u>				╛	┚			
YMBOLS:	<u>V</u>			AT COMP									- PARTIAL LOSS OF DRILL FLUID
31 FAR	V-		R LEVEL		RS AFTER COM		ION		_		_	• -	- TOTAL LOSS OF DRILL FLUID
RL FORM June 198		2	9	HEET 29	OF 37 : A.	-63		•	B	10)F	R III	NG NO. <u>25-5</u>
	-		•			-			_	_			

		NG NO23		-	UITHE					Stalled
Projec	#	u.f. T.			ace um f					3
Date:	Start_	/ / Complete/ /		UIII.	AII I	1	JU	-	_	
Locati	ion N.	E		1		ı			88	
Drilling	g Age	ncy	_		1			3	12	
		inspector	₹	1				1		·
			5	X		_		H	FLUID	LABORATORY RESULTS
Drill	Metho	d	2	Ιž	0	5		CONTEN	王	AND
		of Overburden	31	9	2	15	H	Ŗ	E	REMARKS
		d into Rock	Š	E	ĮΣ	厚	3	H	X	
Total	Depth	of Bortna	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	W	BAMPLE TYPE	URE	₽	
Dir. a	f Bor	ingVertinclinedDeg	97	¥	Ó	를	트	MOIST	Ş	
ELEV.	ΤE	SOIL CLASSIFICATION	180	12	i iii	3	3	0	GHO	
	DEPTH			-	=	8	-	-	0	
12/11	10	SURFACE COVER		├	-	-	-	-		
ŧ	77	1				l				
t .		-SHLOMING AIR SHOUZ'			1					
-	581-					l			П	
E]				ı				
F	18-2	1 '			l .		 		ii	
F	70-]								
F	1 .	= 5HLamina= B/P					2			
L	583-	3					8			
E	1	S# 0.03'								
F		l l								
F	584									
<u> </u>		Mech		1 1						
Ł		·		H		H				Run 11
F	585-	-5H.0.02'		1 1						Cored 10.1
F	:	•		1 1						
ţ.				1				- 1	- 1	Rec 10.1
F	58%	-							-	Loss 0.0
Ė		-5 H Lamina+ BIP							-1	LOST -10
E	CF2	-540.01						- 1	- 1	Time
E	7	-SHLenines						- 1	- 1	
F	:	- Mech Leo						ı	ı	9:20-11:00
F	177-							- 1	1	•
F	:							ı	1	
E 25	584							- 1	- 1	
F (2)	77-	· '					٠	- 1	-1	•
t		es.	- 1					- 1	- 1	
E	192	7 79	- 1		- 1	Į	- 1	- 1	- 1	-
F	-	> 57 y		l	0	- 1	ı	- 1	- [
F					7	- 1	- 1		-1	
_	59/-				Y	- 1	ı	- 1	- 1	•
		-SH0.01'	.			ı	- 1	- 1		
=		- 5+ j ·	ſ		\cdot /		1	١		
-	772	-sty	ł	- 1	19		Ī		ł	•
-	3	- Mech 6-00	ļ	J	6			- [-	
Ŀ	772	-540.01'	- 1	- 1	00		ļ	- [-
<u> </u>	٦.٦	· ·	- 1	- 1	1					
F	7	- meed to		ŀ		- [-			
_	179	-Sty SHLanings BIP					I			-
	1	TLA MINAC DIP				- 1	1	l		
_	1 4	-sty mach	1	٦.					Γ	Ran 12 .
-	175	=5Ty -	- 1			-		-		_
]]		- 1	ŀ					-	Cored 10,3
-	100 F	- Pyrito , - 5 + 0.01'	ſ	- 1	ĺ				.1	
-	["]	-5 H 0,01	- 1			}		-		Rec 10,3
	4	544 SH 0.02	- 1		2			1		Lors 0.0
• •	172			- 1	7.	-				
		-mud beo		- 1	0	7	-		-	7.
:	_ = =	Sty Sty - BIP Mach	- 1	ŀ	√ [•		1		1	Time
<u>-</u>	777-]			ı İ.	160	7				12:30-13:45
]	. Comented Vertical		- 1	100%	4		-		· · · · · · · · · · · · · · · · · · ·
1021	799			ı,	6	Ì			1	•:
	グす	4 / 4	- 1		1	1			ļ	-
	±	Vag a 1		- 1			1		1	;
	610					\perp	┸		⊥	
YMBOL	s: V	WATER LEVEL AT COMPLETION					_		>	- PARTIAL LOSS OF DRILL FLUID

SHEET 30 OF 33 St. A-64

>> - TOTAL LOSS OF DRILL FLUID

BORING NO. ______

BOI					ume					stalled
Project		4. T.P.		Surf						71
Date:St	art_	_/ _/ Complete/ _/		Det	ATI T	x :	SU	EC.	9 6	7
Locatio	n N_								8	
Drilling	Age	ncy		1	Į			3	2	
Driller _		inspector	₹		l			2	₽	
			E	天				Z	되	LABORATORY RESULTS
Drill M			5	Ιž	٥	5		Ę	之	AND
Thickne	33 0	f Overburden	F .	•	2		핃	Ŗ	ATER-	REMARKS
		into Rock	18	5	ĮΣ	ΙŞ	Ξ	E	3	
Total D	epth	of Boring	3	1	5	4	щ	5	ē	
Dir. of	Borti	ngVertinclinedDeg	究	Į ≅	ă	를	Ē	181	Ž	
ELEV.	Ē	. SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	3	SAMPLE TYPE	0	GRO	
101,12	EP	SURFACE COVER	_	-	-	-	3	_	۲	
-100.81	(20	SUNFACE COVER		 		Н	Н	_	Н	
F (700.0				1		l				•
F	41								H	•
F	7/-	<i>, •</i>					H		ı	
F	:	-Vus		l			l			
988'	42						П		Н	•
-16.4		-mech Geo					2		l	
F							1			_
F .	- (00	LAIP Open Parous to V. Parons					8			•
=	:				1	Н	ľ			
L	64_	-Mich Elev 98,8'- 923'								
.		much				1				
.						H				
-	<i>105</i>									Run 13 -
E		BIP Open				H				Cored 10.1
Ŀ	CAC	P/45				H				
	3	BIP Open								Rec 10,1
- 45	3				ŀ					Loss 0.0
-	47-	Cv.,								•
E :	3	[,,,]					l			Tine
ΕΙ	405									14:20 - 16:05
	Ξ.	- BIPOren								11120 10:05
92,3'	3									Some Testable 4 "Sections
1	601-						4		- 1	JOME 18514919 1. Dections
	3					-		- 1	- 1	
-	110	- RIP SH 0.01°						- 1	ı	نے
		SHLaminaz BIP			6		- 1	- 1	- 1	•
-	3	- Sty			6		- 1	Į	- 1	_
-	<i>*#</i> -	-Mech SHI - 1 Ava	i	ĺ	. "	- 1	ı	- 1	- 1	-
	3	- Mach SH Laminac BAP	•		V	-1	- 1	ı		
- 1	,,,]	- mech too			.]	١:			-1	
- 1	≈ ≥∃	- 411271 -19			J	- 1	ı	ı	- 1	-
.	7		- 1		63	1		- [-	:
- 1	羽士	-SH Lamina & BIP			6			-	-	
	7				Y		1	-		:
L5	,, <u>,</u> ,‡	- SHO.03' SHODI'	I		- 1		- 1			:
/	‴₹	cui. I ain	i		-	Ì	-	-1		-
	7	-SHLamina + BIP	j					- 1		
-	615-	Sty Mech Most	- 1	ł	\dashv				ŀ	Run 14 6/3
	7	SH Lamino CBAP Kotal Filled Ving	l	1				- [
<u> </u>	u F	-SH'0,01°	ı			-	- [1		Cored 10.3
- 1	3	۵.	l		-	- [-		l	Rec 10.3
	. ∄	- Sty - Mechter - SHLaminge		- 1	2					1.
- ' k	<i>"/</i> }	- 14864 0-69	- 1	- 1		8	1			Loss 0.0
- 1	3	1	- 1		01		1	١	ı	Time Gum
<u> </u>	64. F	- 54 Y SHO.OF		- 1	√ľ.	X	١	1		Time 8:47-11:30
	~3	Xstol Filled Vag			1,,	9	-	1		C. T. 411 2 41 5
1	. 7	· · · · · · · · · · · · · · · · · · ·	- 1	- 1	1.4			ı	ŀ	Some Testable Sections
<u> </u>	49-	ZSH Laminas BIP	- 1		20	1	ı			· •
: <u> </u>	4	- 110.01	- 1		7					
: [00 t	- SH 0.01 to 0:03			- [•
YMBOLS		WATER LEVEL AT COMPLETION				_	_		┪	- PARTIAL LOSS OF DRILL FLUID
	Ť	- WATER LEVEL HOURS AFTER COM	PLETI	ON						- TOTAL LOSS OF DRILL FLUID

SHEET 3/ OF 23 A-65

		NG NO. 283								stalled
Project Date:S					um f					9
Locatio		•		T	T	1			_	
		ency	1				П		1088	
Driller .		inspector	z	1	1	ı	П		_	
	Туре		1 2	1=			П	토	5	LABORATORY RESULTS
Drill A	•••		3	ΙŞ	1_	<u></u>	П	巴	Ę	AND
		of Overburden	Ē	FINCH	물		ш	3	띮	REMARKS
		ed into Rock	88		15	3	5	0	7	REMARKS
•		of Boring	CLASSIFICATION	1	E	Z		릭	₹	
Dir. of	Bo	ringVertinclinedDeg	90	3	Ş	글	립	티	3	
ELEV.	ΤE	SOIL CLASSIFICATION	8289	BLOWS PER	띮	3	SAMPLE TYPE	٥l	GROUNDWATER-FLUID	
	DEPTH	SUIT OF SOUTH	-	-	-	8	9	-	0	
81.1-	22	SURFACE COVER	-	┼	⊢		Н	+	-	
80.7	-	-Moch Cemented It Eleu 80,7-79,7' Vus Xstol -SHLomina & AM		ı			П			
_45	21	Vus Xstol	ı	1				- 1		
79,7"		- SHLomiane AND		ĺ						
	l	- MUAUED						- 1		
-		-Vug, Xstol, Mach								•
-		4 —						-		
<u>.</u>	(22	1	l						-	•
1.		- Commented It					z	-1	١	
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MBOI S	4	WATER LEVEL AT COMPLETION				-	_		_	

SYMBOLS: WATER LEVEL AT COMPLETION
WATER LEVEL ___ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

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VI	MBOLS	. 1	WATER LEVEL AT	COMPLETION					_	_		Ļ	- PARTIAL LOSS OF DRILL FLUID

WATER LEVEL AT COMPLETION
WATER LEVEL HOURS AFTER COMPLETION
ORL FORM 1202
1 June 1988

>> - TOTAL LOSS OF DRILL FLUID BORING NO. C5-5

			6 18 193 Complete / /		Sun	face	Ele		юп	Installed
	Locatik Drilling Driller : Drill A Thickne Depth : Total D Dr. of	on N. Age Ter Type. Metho ess (Drille Born	Reser's Holler E Ft. Knex Ky ancy Affect Bres Stiller III Inspector Perses Failing Hale Mester CF-IT and J H " Sit, 47 Str. 28" (er z of Overburden 44.0" of Boring 646.8" ing X Vert Inclined Deg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	Œ	MPLE TYPE	ISTURE CONTENT (%)	LABORATORY RESULTS AND REMARKS
_	LEV.	DEPT	SOIL CLASSIFICATION	3	표	뿐	8	<u></u>		8
	12.9°		SURFACE COVER	_	-	_	Н	+	+	
استناسيناسيان		2 3	Crested Grove (0-0.4') Reddish Brown, SILTY CLAY Moist, Soft to Medium Stiff (0,4'-4,5') Browish Red to Red, SILTY CLAY, Moist to Romp, Medium Stiff to Stiff (4:5-44,0')				-			9% "Tricone Roller Bit to a depth of 49ft Installed 6"Sch 80 P.K.C. to a depth of 49Ft, 1Ft Stickup Changed to 434" air hammer bit at 49' 2% "Core
-	/	التعطيمة								Christson NG5WL CorcBorrel Using a surface set
	/.	ستراسيل	·							25C+ SN 35 Ø 38649 Typz Ø 2 Ø 406676
•	. 13	عيتلسن								Changed Drill rigs to Core Joy 22B
•	. 17	Jana								Set NX casing to a
	18	عظمما								212.8'
/ME	20 10LS:	7	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP						}	- PARTIAL LOSS OF DRILL FLUID

SHEET ___ OF _33 SI A-69

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Project Dete:Start				um fi				8
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	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIGD	Ŧ	SAMPLE TYPE	GROUNDWATER-FLUID	
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	WATER LEVEL AT COMPLETION						7	- PARTIAL LOSS OF DRILL FLUID

WATER LEVEL ___ HOURS AFTER COMPLETION

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Date:Start_	Comp	lete/_/_		Date	ım fi	or S	Surfe	ce	EI
Drilling Age Driller Drill Type Drill Metho Thickness (Depth Drille Total Depth Dir. of Bori	incyinspecto id of Overburden d into Rock of Boring ingVert	InclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIQD	MPLE NUMBER	MOISTURE CONTENT AKY	DUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
G72.8		SSIFICATION	CS	7	Æ	8	젊일	GR	
672.8 6	SURFA	CE COVER					I		
1/2 1/3 1/4 1/5 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4	T.O.R. SHALE, Light Soft to Mad Ha	it Gray,							
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BOLS: V-V	VATER I SIZEL AT CO.	4D4 ETIGO			Ш	\perp	Ш		
FORM 1202	VATER LEVEL AT COM VATER LEVEL HO SHEET	MPLETION DURS AFTER COMPI 3 OF 3 3 S A-7			P	0	>>	•	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

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MBOLS:	V V	VATER LEVEL AT COMPLETION						-	- P	PARTIAL LOSS OF DRILL FLUID
RL FORM 1		VATER LEVEL HOURS AFTER COMPL	ETION -7つ	1		_	_ ;	>>	- 7	TOTAL LOSS OF DRILL FLUID

SHEET 7 OF 33 SHE A-72 BORING NO. 15-6

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YMBOLS	7	WATER	I EVE	AT COMP	I ETION					_	1	_	Ļ	- PARTIAL LOSS OF DRILL SLUID

WATER LEVEL ___ HOURS AFTER COMPLETION

ORL FORM 1202 1 June 1988 SHEET 5 OF 33 SI A-73 > - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

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ORL FORM 1202 1 June 1988 SHEET 6 OF 73 SHL A-74

>> - TOTAL LOSS OF DRILL FLUID

BORING	NO			instru Surfa					Installed
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Orilling Agency_			_ [3	
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ir. of Boring	VertInclined_	Deg	USCS CLASSIFICATION	BLOWS PER 6-INCH	ПЕСОVЕЯУ/ЯQD	1	SAMPLE TYPE		
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SHEET 2 OF 33 S A-75

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SHEET 5 OF 37 SHI A-76

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SHEET 7 OF 33 & A-77

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SHEET 10 OF 33 SHI A-78

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SHEET 12 OF 33 SHL A-80

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SHEET /3 OF 33 : A-81

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SHEET /9 OF 33 SHE A-82

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SHEET 15 OF 33 A-83

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SHEET 6 OF 33 SHE A-84

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SHEET 17 OF 37 s. A-85

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SHEET /8 OF 33 SHE A-86

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SYMBOLS: WATER LEVEL AT COMPLETION
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MBOLS: WATER LEVEL AT COMPLETION				_		÷	- P	ARTIAL LOSS OF DRILL FLUID
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SHEET 2/ OF 33 SI A-89

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ORL FORM 1202 1 June 1988 SHEET 22 OF 33 SH A-90

Project	NO	•	Surf	ace	Ele	vat	lon_	
Drilling Agency Driller Drill Type Drill Method Thickness of Over Depth Drilled Into I Total Depth of Bori	burden	MASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	GROUNDWATER-FLUID LOSS	EI. LABORATORY RESULTS AND REMARKS
910 910 910 910 910 910 910 910							>- >>-	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID
1 June 1988	SHEET 23 OF 33 A-	91		B	0			G NO. 65-6

>- PARTIAL LOSS OF DRILL FLUID
>>- TOTAL LOSS OF DRILL FLUID
BORING NO.

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roject	11	Complete	//			Det						8.
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rilling Agent	γ									-	1089	
riller		_ Inspector			Z					3	-	
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hickness of			E	1	ğ		M	Ŕ	Ē	REMARKS		
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tal Depth o	Boring_	ertinc	M 4		ਰ	9	1	4	4	5	9	
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SHEET 24 OF 33 SH A-92

BORING NO. ______

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Date:	Start _	/ / Complete/ /		Date	ım f	or :	SU	TEC		۲
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ווחט	Type_		5	돐		_		놂	3	LABORATORY RESULTS
	Method		Ş	Ž	٥	5		臣	E	AND
		f Overburden	15		2		뿐	8	12	REMARKS
Total	Drive	1 Into Rock	1 8	Ü	2	呈	≥	빌	Ş	•
Dir o	Jepui J Bodi	of Boring	ರ	9	7	백	쁘	Ę	2	
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIQD	5	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID	
ELEV.		SOIL CLASSIFICATION	3	8	2	8	8	ĭ	5	
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:	1	1		Ì		1			1	BIP- Bedding Plant
: [400	i						1		Mech - Mechanical Brak
- P	799	_ }								Geo - Geologist
: [_ ‡						1	ı	1	SLs - Sittstone
	560-					L	L	L	L	
YMBOLS	. ★	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	LETIC	N				>	>:	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

SHEET 25 OF 33 A-93

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Project	// , T , P ,			face					7
			U	um f	or i	SULT	_	_	
Location N_		1		1	-	П		088	
Drilling Ager	inspector	_					3	2	·
		Ó	1				Ĕ	2	
Drill Type_ Drill Method		1 2	6-INCH	1	_		짋	F	LABORATORY RESULTS
	f Overburden	1 2	Ę	18			뒫	TER	AND
	i Into Rock	2	1 2	E	E	ē.	8	E	REMARKS
Total Depth		13	2	≩	Z		삗	Ĭ	
	ngVertinclinedDeg	5	8	=			리	뵑	
		JSCS CLASSIFICATION	BLOWS PER	RECOVERY/RQD	SAMPLE !	SAMPLE TYPE	8	BROUND	
2/28" a	SOIL CLASSIFICATION	3	0	=	8	<u>@</u> :	3	ᅙ	
	SURFACE COVER	<u> </u>				4	4	4	
F. 1"4	Mech Light Gray	1					1	- 1	Start 26 Core with :
F 1-1-1	- Med Way					2	- 1	1	Joy 228
F 1"/7		1			6	*	1	1	
EIŦ	-Mech				OX	8	1	-1	Depth 500.1'
F 502-7	_ Meah - Light bray				X		1	1	
E 1	- Mech				1				Eku 2/27'
E ba.≸	Light fray						-		Run /
E I"7	7 * y					ı			Lored 9.9 Rec 7.9
E 4	M /				1			ľ	
	- Mech				- 1		1	1	Loss 0.0'
5#	-Core spin pyrite	ii					ı	1	Time 8:35- 9:30
E '' 185=1	- Mech	1 1	- 1				1	1	world
	-pyrite	1 1		- 1	ł			1.	Semple Outh Elev =
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	-SL5 0.01		- 1	V			1	ı	
97	5Ls 0.02 - Meek		1	10			1		2 5050 2078 1 507.1 2057
E 3	Sts Mech		- 1	00				1	. 7
25	Station 2		- 1	7					3 <u>507.7</u> <u>205./</u> 508.8 <u>204.0</u>
	SLSLen	li			1		l		508.8 204.0
-	Couspia				1		.	L	. CASS 2040-
- 1-/-1			- 1		1		L	1	-1 <u>508.8</u> <u>204.0</u> =
	SLS La miant		- 1	ı		ì			
	Mech		-	-		1	L	F	100 % hoter Return
	- SLs Lanin e - Mooh			- 1	1	1	ı	1	Run 2 Cored 4.8'
-113			- 1	- 1			L		Rec 4.8 Losso.0' 3
· /" =	SLS Laminac Mech	- 1				i	l		
		•	- 1	2				L	Time 11:20-14:30 =
5/2-	(New Hibany Shale)	- 1		10					Somply Death Elev
	SHALE, Brown Black to Black,		- 1.				ĺ		No 5/1/ 2017-
- 173-	Till		- 1,	10			ĺ		No 511,1 201.7 =
1 4	Thinly Laminated, Soft to Medina Hard, of Occ Siltstance	- 1	Ι.	0	1			l	3//// /////
-,,-	Medina Hard, W/ Occ St/ tstone		-	001				ı	4
7//3	_SLSLAMINOR LEASES and					П			4
	Much pyrite nadules	- 1		-		П			100 % Getter Robert
. 127				7				1	Yun 3 Cored 500 =
1	Mech.	- 1		L	1				
516-				8			İ	·	Rec 5,0 Loss 0,0
[4	1	-	1:				ł		7
5/2			K	2 2					Time 15:30 - 16:00
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1_1				V				5	Comple Depth Elev =
5%-1	Mech SLELaninae		1						N_{μ}
E	- LAMINAE		3		П		- [6 518.00 194.8
5193						- 1	-1		521,7 1711
1 4	- SLS Lemiage Zonc						- 1		7
6,45	- 16) Lemiage Zoal	ŀ	1			1	1		4
MBOLS: V	VATER LEVEL AT COMPLETION				Ш		ᅼ	_	PARTIAL LOSS OF DRILL FLUID
	WATER LEVEL HOURS AFTER COMP	PLETIO	N			,			TOTAL LOSS OF DRILL FLUID

SHEET 25 OF 33 St. A-94

		NG NO								stalled
Project		// Complete/ /		Surf. Data						· ·
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		nncy	· ·			ı	ı		988	
Driller .		Inspector	z	1			ı	3	1-	
	Туре		일	=	1	l	ı	Ę		LABORATORY RESULTS
Drill A	••		5	달		g		旧	圧	AND
Thickne	853	of Overburden	₫	J	걸	100	w	18	TER	REMARKS
Depth	Drille	d into Rock	9	5	2	ĮŞ	12	10	3	
		of Boring	CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	<u> </u>	SAMPLE TYPE	MOISTURE CONTENT	Ş	
Dir. of		ingVertInclinedDeg	USCS	Ž	Ŕ	Ē	1	2	Ž	
ELEV.	DEPTH	SOIL CLASSIFICATION	 Š	三	Ä	3	3	2	Ĕ	2
1928	7 🗒	SURFACE COVER				-	۳	F	Ť	
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. •	1	-5250.04		1					П	
1965	12/-	SLS LOAINAC	ľ			ĺ	l		П	
7765	1	- SLS 0.04 . (Jeffressarilk Limestone)				ı				
	522.									T + 4 / /
,	[Limestoney In Brown To			.					Trace of Hydro carbons
45	_	Limestoney Ton Brown to -sty Lt Grayg Hordy Fossiliterous, 								in Jeffersonville
-	523-	Mech Fotons					2"			Some Sections will
•		5 ty								
	524] ,					1			not poss wire Test.
188,3		Mach								for Jeffer paville Limes tanz
	مح	- Much Sholey Limestone								
		Shale								Runy
		Mech		.						Cored 10.1'
•	126-	!								Rec 10.1'
1 -	:	-Sty			ı				- 1	Loss O.D
Ls	727	1	1					- 1	-	•
		BIPOpti			- 1				١	Time 16:30-17:30
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	2/-	-81P Optn 5# 0.02	- 1	- 1	- 1	- 1	4	-1	ļ	•
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	76-	,								Rec 10,1
	4					I				
·	77		- [-				1	1	Loss 0.0
	3	- Mech Geo	- 1	- ,	Ó		1			Time 8:30-9:00
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5	307			\perp		L	1	L	\perp	
MBOLS	÷ ∑	WATER LEVEL AT COMPLETION							>	- PARTIAL LOSS OF DRILL FLUID

SHEET 27 OF 37 . A-95

BORING NO.

Project U. T.P.							Installed
Date:Start/Complete/ /			ace				
Location NE		700	<i>un 1</i>	1	307	C C	e B
Drilling Agency	1		-				880
Drillerinspector	z				П	3	3
Drill Type	2	=	1	1	П	Ę	5
Drill Method	5	2		Œ	П	티	LABORATORY RESULTS
Thickness of Overburden	E	2	ğ	ĕ	삗	3	AND REMARKS
Depth Drilled into Rock Total Depth of Boring	Ž	5	٤	5	٤	0	T REMARKS
Dir. of Boring Vert. Inclined Deg	ಠ	8	VER.	9	4	5	
	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIGD	Ē		5	LABORATORY RESULTS AND REMARKS
- OUL CLASSIFICATION	5	10	분	8	최	3	5
					\Box	T	
F. 4 (- 1		9	T	
141 Limestone, Light Gray to Gray,			ı	ŀ	2		1
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	- 1			ľ	8		:
Ls ST2 - Mich or Perons From St 1/14	- 1	- 1	ı	- 1	1		
E J J White,	- 1			-		ı	:
573- my Occ Shah Laminazor	- 1	- 1	- 1	-		1	1 =
- Tilled Ded W/ Occasional					1		1
Chart nodale	- 1		-1	1	1		1
F []	- 1			1			-
E L., 1	- 1	- 1		1	1		
E PTS- MYCh	- 1	-	4				
Sh. Laminaz Zonz			1		1	1	Rua 6
Mech Zone							Cored 10,4 Fa. Bottom
Stole Laminar 0.01 to 005 ipart	- 1					П	Rec 10,4
197 - Sammer D. Ol To Des apart	- 1						Loss 0,0
165.3 " Frech Porous to					П		
BIR Open Very Porens				1			Time 9/30-10:00
Orath Elav							
			1	П			4
				1/1		- [
nir basa					-1	-	Some Sections of
. 1 3 **********************************	- 1		П	Н	- 1	1	core will not part
BIP Open Sol		1.	П	- 1	- 1	1	THE WILL NO PACE
-LS STA SALamin or Sh. 0.01'	- 1		1 1		- 1		70 To mater Return 3
Solution Sh. 0.01	- 1	100	11	-			4
mech .		0	П				for rest of Burney
sty		1.	Ы	1	1		··
BIP Solution		20		-1	1		3
±57y		100	X		1		4
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<i>∞</i>						1	· ‡
1 - mech	1 1						4
577					1		340 7
Mech						ı	
mech 10	11		-	1			ored 10.4
AIP Dorn Solation		7					Pec 11,4
CHI GET AIR C. L. L.		0.9	1			2	0450,0
SYLL BY BIP Open Solution		0					Time 10:05-10:35
54 /2010	I I	\mathcal{V}_{i}	1		П		7
5 39 Con Spin		60				•	fore out of spre
- Sh Laminer		100				1	or sime sections
IROLE TO MATERIAL TO THE PARTY OF THE PARTY		\perp			1		
MBOLS: WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMPLET	701				>	- 1	PARTIAL LOSS OF DRILL FLUID
FORM 1202	ION				>>	- 1	TOTAL LOSS OF DRILL FLUID

SHEET 7 OF 33 SH A-96

BORING NO. Co.

rolect	`	NG NO. <u>(5-6</u>		Surf	BC8	Ele	V8	ior	_			
Date:St	art_	Complete		Dett	m f	or :	Sur	face El				
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orliling	Age	ncy	l _					3		1		
		Inspector	₹	1	ł			T (
	ype_		F	동		-		S	95	LABORATORY RESULTS		
orill M		f Overburden	문	3	2			Z	Ē	AND		
****		i into Rock	5	2	Ĕ	Ę	9	8	E	REMARKS		
		of Boring	ΙŠ	1	È	Z	F	RE	Ž			
ir. of	Bori	ngVertInclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	물	SAMPLE TYPE	5	ž			
		<u> </u>	1 8	9	8	3	3	913	2			
LEV.	DEPTH	SOIL CLASSIFICATION	3	-	R	8	8	3	ō			
52.8'	ō	SURFACE COVER	_	-			Н					
45	121	- 5h Laminat Sty	1									
5181	زرسا	-54 Laminae										
7770	56/-		1				1 1					
	:	Sh La mina z							H			
	\$2-	- mean Page 2 3.	ŀ				,					
		-3A LAMIAAT					2					
	572	54 0.03 Depth Elev 54 0.01 St.1.0 15/18' 54 Laminac 577.5 135.3'	l	1			١. ١					
		Sh. Laminac 561.0 15/18					1/2					
	•	577.5 135.3										
		=Sh Lamungz										
	-	Va 5										
	525-	-Vag										
	-	≧ st _v		ll								
	T6							-				
	-	-,.Stv								Run8		
	1	- BIP Sol Core Spin						ı		Cored 10.0		
	77.	or the contract						ı		Rec 10.0		
	3	-54v						١	١	Loss 0,0		
.5	568	-Vas BIP Solation						ı		2000		
	-	Di 30/4 7100						-		Time 12/30 - 15/39		
ı	565	54001-540.03						1				
	"/=	_370					1	- 1				
	3	- Care Spin				١				corrout of spec		
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	3	ShLaminar			3							
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	_]	7-5h Lamina 2 0.02 - 0.05 apart -	·		1	\dashv		1	1			
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P	7	- BIP Open Solution			- 1	I						
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5	7	- Mach	- 1	-	—			I	L			
	4	-ShLaminaz								Run 9		
, k	777	-57y	1							Cored 10.1		
5.31	F	''/								Rec 10,1		
<u>"-</u> "		-540.05'			3							
1	7F-]	-Stv	1	-	7				1	Loss 0.0		
	3	′	. [N					Time 13:41-14:20		
k	79]				14		-					
ľ	′ ∃				0					Occassinal Small rugs		
L	لمبيح	-SA Laminat	1		13			ļ		•		
IBOLS	W. T	WATER LEVEL AT COMPLETION	1						ŕ	- PARTIAL LOSS OF DRILL FLU		

SHEET 27 OF 33 SI A-97

BORING NO.

POUI		•		rume					stalled
Project	u.T.P.			ace		-			
Date:Start	/		Det	um f	or .	SU	TEK	- 1	
Location N_					-		1	88	
Drilling Ager		· _		t		ŀ	3	암	
	Inspector	1 8	1			1	15	9	
		15	天		_		温	3	LABORATORY RESULTS
Orll Method		1 5	Ιž		旨		Ę	1	AND
	f Overburden	1 15	•	2	13	ш	ĮŖ	巴	REMARKS
	i Into Rock	Ass	F	1	13	Ξ	in in	₹	
Total Depth	of Boring	ㅁ	8	ĕ	4	щ	5	9	
or. of Borin	ngVertInclinedDeg	J USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIQD	를	Ē	18	ᅙ	
LEV.	SOIL CLASSIFICATION	T Š	1	夏	SAMPLE NUMBER	Z	9	Ĕ	
32.80	SURFACE COVER				-			Ì	
880-									
. 1	- Mech								Some of love on tof
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7′′ ‡	= Mech				П	ĺ			Spre
1, ±	- D.O.S.Chert -S4 Laminal	1					-		
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an I	-Chert	1						-	Occassicaal smallungs
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7 575	- 8.05°Loss Loss al' Sh Corrspin	1 1		0	-1			1	LOSS 0,15'
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	WATER LEVEL AT COMPLETION				-	_	_	_	PARTIAL LOSS OF DRILL FLUI

SHEET 30 OF 33 SH. A-98

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YMBOLS: V	WATER LEVEL AT COMPLETION	1						_	- PARTIAL LOSS OF DRILL FLUID		
*	- WATER LEVEL HOURS AFTER COM	APLET	ION					>>	- TOTAL LOSS OF DRILL FLUID		
RL FORM 120	SHEET 3/ OF 35 A-9	9			D	20) E		NG NO. CC-6		
June 1988	SHEETOF							28	170 170.		

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	of Overburden	Ĕ	3	8		w	CONTENT	TER	REMARKS
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SH SURFACE COVER SH 190 SH 214 691 192 (Laurel Dolomite) 192 (Laurel Dolomite) 193 (Laurel Dolomite) 193 (Laurel Dolomite) 194 (Laurel Dolomite) 195 (Laurel Dolomite) 196 (Laurel Dolomite) 197 (Laurel Dolomite) 198 (La	Drill 1	Type_		¥	I	i	'	1	뉟	5	LARGRATORY RESULTS
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Sty Occussional Stylolite and Oark Bands 640' Sty Shoo3' B.O.H.	L	107	- Mech Sty								7 636.2
Sty Occussional Stylolite and Oark Bands 640' Sty Shoo3' B.O.H.	E00/	17/-								1	738.3
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Sty Occussional Stylolite and Oark Bands Sty Shoo3' B.O.H.	ļ.	14:	14 4 1 111 1							-1	10 638.3 74.5
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AVIANCIA TO MATERIAL PROPERTY OF THE PROPERTY	DVIATO: 0			\perp			1		L		
SYMBOLS: WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLU WATER LEVEL HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLU	MBOLS	. *	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	LETIC	NC				,	?	- PARTIAL LOSS OF DRILL FLUID

SHEET 43 OF 33 : A-101

>> - TOTAL LOSS OF DRILL FLUID

Project 10. T. I. Determined N. Macro: Tables E. Fr. Kack, Ky Drilling Agency Daily: Bree Drilling Agency Daily: Bree Drilling Agency Daily: Bree Drilling Agency Daily: Bree Drilling Agency Drilling Agency Daily: Bree Drilling Agency Dril
LOCATION N. Res. 1. Hollow E. Ft. Knex, Ky Drilling Agency Bulley Bree Drill Type Fallicy Hold Destric 1-15 Drill Type Fallicy Hold Destric 1-15 Drill Type Fallicy Hold Destric 1-15 Drill Type fallicy Hold Destric 1-15 Drill Method ? Y' Sit, 44 H. H. J. X. Y' Total Depth of Boring 136.7' Total Depth of Boring 136.7' Total Depth of Boring 136.7' Dr. of Boring X Vert Inclined Deg ELEV. E. SOIL CLASSIFICATION 306.9 ELEV. T. Soft to Medican Stiff (0-4) L. Herry, 3 of to Medican Stiff (0-4) L. Herry, 3 of to Medican Stiff (0-4) L. Herry, 8 of to Medican
Drilling Agency Date Mess Drilling Agency Date Mess Drilling Tex 5the Minspector Faceure Drill Type Filler Harlefflerth Fill Tex Thickness of Overburden 39.0/ Depth Drilled into Rock 597.7/ Total Depth of Boring L36.7/ Dr. of Boring Next Inclined Deg ELEV. 5 SOIL CLASSIFICATION 500 By By By By By By By By By By By By By
Drill Type Fills, Halk Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr Kit 4 His hit 1 First Mathod Jr
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
SURFACE COVER Lt Benur, SILTY CLAY, Next, Soft to Medium Stiff (0-4) 2 Tostalled 6" Seh to Rive, to a depth of 43 f. Tostalled 6" Seh to Rive, to a depth of 43 f. Toliq 5 Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Kelore deitled using a Joy 22 B and 312" Casing from
Lt Brown, SILTY CLAY, Not t, Soft to Medium Stiff (0-4) 1 Stiff (0-4) 1 Installed 6" Sch to P.U.C. to 9 depth of 43 f. Reddich Brown to Dark Red, SILTY CLAY wy Chert Fragments, Damp to Moist, Stiff to Very Stiff 2 Ver (our drilled using a Jay 22 B) And 316 Casing from
Total to a depth of 43 for to a depth of 43 for the stiff (0-4) Total 4 Limestone, Bonider (4-5) Reddish Brown to Dark Red, SILTY (LAY w/ Chert Frogments, Damp to Moist, 5 tiff to Very 8 2 // Core deilled 4 using n Joy 22 B 4 and 3 // Casing from
Total (0-4) Installed 6" Total 4 Limestone, Boulder (4-5) Reddish Brown to Dark Red, SILTY (LAY w/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Vo (ore drilled using a Joy 22B) And 3K Cosing from
Installed 6" Joseph Goding Total 4 Limestone, Boulder (4-5) Reddish Brown to Dark Red, SILTY CLAY w/ Chert Frequents, Damp to Moist, 5 tiff to very 8 2 Vo Core drilled using a Joy 22B and 3K Cosing from
Justalled 6" 3- 702.9 4 Limistone, Boulder (4-5') Reddish Brown to Dark Red, 5 ILTY (LAY w/ Chert Fragments, Damp to 1- Moist, Stiff to Very 5tiff 9- 2 Ve Core drilled using a Joy 22B and 312" Casing from
TOZIG 4 TOZIG 4 Limintonia, Boulder (4-5) Reddish Brown to Dark Red, SILTY CLAY W/ Chert Frogments, Damp to Moist, Stiff to Very Stiff 2 Ke (are drilled using a Joy 22B) And 3K Casing from
TOZ.4 4 Limestone, Boulder (4-5') Reddish Brown to Dark Red, SILTY CLAY W/ Chert Frogments, Damp to Moist, 5 tiff to Very 8 2 1/6 Core drilled using a Joy 22B and 31/6 "Cosing from
TOZ.4 4 Limestone, Boulder (4-5') Reddish Brown to Dark Red, SILTY CLAY W/ Chert Frogments, Damp to Moist, 5 tiff to Very 8 2 1/6 Core drilled using a Joy 22B and 31/6 "Cosing from
Limestone, Bonidor (4-5') Reddish Brown to Dark Red, SILTY CLAY w/ Chert Fragments, Damp to Moist, Stiff to Very Stiff 2 1/8 Core drilled using a Joy 228 and 31/8 "Casing from
Reddish Brown to Dark Red, 6- SILTY CLAY w/ Chert Fragments, Damp to 7- Moist, 5 tiff to Very 8- 10- 10- 10- 10- 10- 10- 10-
Reddish Brown to Dork Red, 6 SILTY CLAY w/ Chert Fragments, Damp to 7 Moist, Stiff to Very Stiff 10 using a Joy 228 4 and 31/2" Casing from
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1- SILTYCLAY w/ Chert Fragments, Damp to Moist, 5 tiff to very 5tiff 2 1/6 (ore drilled using a Joy 2218) and 31/6 "Casing from
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8 Stiff 9 2 Valore drilled using a Joy 22B and 31½ "Casing from
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- 16 Fine SANOY STLTY CLAY 2,985 RSG Green
1 1 Moists Stiff
(15-39') SN 35-037574
(575-6367)
Impregnated Bit
19= 2,985 RSC Gerra.
SN 35 Ø 386 Ø4
203
YMBOLS: WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLUID > - TOTAL LOSS OF DRILL FLUID > - TOTAL LOSS OF DRILL FLUID

SHEET _/ OF 32 SI A-103

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SHEET 2 OF 92 SHE A-104

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YMBOL	s: V	Z WAT	TER LEVEL	AT COMPL	ETION				_	_		Ļ	PARTIAL LOSS OF BOTH
	Ţ	- WAT	TER LEVEL		S AFTER COL	MPI FTI	NC					⟨`	PARTIAL LOSS OF DRILL FLUID

SHEET 3 OF 32 S A-105

BORING NO. <u>CS-7</u>

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USCS CLASSIFICATION			-		NT (%)	11D LOSS *	
USCS CLASSIFICATION	OWS PER GINCH	ROD	-		NT (%)	11D LOSS	
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SHEET 4 OF 32 SHI A-106

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S: V WATER LEVEL AT COMPLETION			Ш					PARTIAL LOSS OF DRILL FLUID

SHEET 5 OF 32 . A-107

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BOLS: 👺	WATER WATER	LEVEL AT COA	APLETION OURS AFTER	ROMP	LETIO	N						- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID

SHEET 6 OF 32 SHE A-108

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SYMBOLS	: \$	WATER LEV	EL AT COM	PLETION URS AFTE	R COM	PLETI	ON					,>	- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID
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MBOLS	¥.	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COM	PI FTIC)N						PARTIAL LOSS OF DRILL FLUID

SHEET F OF 32 St A-110

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SHEET 9 OF 32 : A-111

. BOF	MIN	NO <u>u.T.P.</u> Comple	15-7	_	Sun	ece.	Ele	VE	tion		alled
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Driller Drill Ty Drill Me Thicknes	rpe nthod ns of C	inspector		IFICATIO	BLOWS PER 6-INCH	/RQD	SAMPLE NUMBER	/PE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID L	LABORATORY RESULTS AND REMARKS
Total De	pth of E Boring_	Boringli		G B	W8 PE	RECOVERY/RQD	PLEZ	PLET	STURE	MONO	
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YMBOLS: 7	- WAT	ER LEVEL AT COM ER LEVEL HO	URS AFTER CO	MPLEΠΟ Δ-112					>> >>	- PA	ATTIAL LOSS OF DRILL FLUID

SHEET ____OF 32 SHE A-112

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rilling Age	ncv.										1083	
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SHEET // OF 32 s A-113

BORING NO. <u>CS-7</u>

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YMBOLS:	<u>V</u>		LEVEL AT	COMPLETIO	ON COLUM						_	> -	PARTIAL LOSS OF DRILL FLUID

SHEET 12 OF 32 SHLA-114

>>- TOTAL LOSS OF DRILL FLUID
BORING NO.

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Drilling Agency	/ Inspector	_			ı		3	2	
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	Overburden	#s	0	2	量	쀮	8	12	REMARKS
	nto Rock	₹	Ē	I≩	13	7	m	Ş	
Total Depth of	VertInclinedDeg	ರ	90	9	4	백	5	9	
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MBOLS: V	ATER LEVEL AT COMPLETION							>	- PARTIAL LOSS OF DRILL FLUID
RL FORM 1202	ATER LEVEL HOURS AFTER COM	PLETIC	ON		_	_	_;	>>·	TOTAL LOSS OF DRILL FLUID

SHEET 12 OF 32 A-115

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ler	Inspector	<u>~</u> <u>~</u>				17	46	1	
Type		—— Ĕ	ま	- 1		15		LABORATORY RESULTS	
Method_		<u>2</u>	ΙžΙ		띫			AND	
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	Into Rock	\$		≧	로		1 3		
el Depth of	f Boringinclined		8	3	쁴				
			BLOWS PER 6-INCH	RECOVERY/RQD	BAMPLE NUMBER	BAMPLE TYPE	ACIONE CONTENT		
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SHEET 14 OF 32 SHE A-116

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		of Overburden	3		Ę	3	PE	8	E	REMARKS
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			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	3	3	810	GROUNDW	
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YMBOL	S: V	WATER LEVEL AT COMPLETION				_	_		<u> </u>	- PARTIAL LOSS OF DRILL FLUID
		WATER LEVEL HOURS AFTER COMPI	LETI	ON					> >	- TOTAL LOSS OF DRILL FLUID

SHEET 15 OF 32 SI A-117

BORING NO. _______

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Driller	Inspector		z	1				3	7	·	
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YMBOLS: 💆	WATER LEVEL AT COMP	LETION BS AFTER COMBI							> -	PARTIAL LOSS OF DRILL FLUID	

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Drill Me	ethod		3	말	۱.	5		E	Ŧ	AND		
		f Overburden	Ē	P	Į	9	M	Š	E	REMARKS		
		Into Rock	Š	Ē	₹	Ę	Σ	E	Ş			
Total De	opth c	of Boring ngVertInclinedDeg	ರ	8	Ž	4	Щ	5	NDWATER-FLU			
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	H	SAMPLE TYPE	MOISTURE CONTENT	9			
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SYMBOLS:	▼	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COMP	FIIC)N				`	>:	PARTIAL LOSS OF DRILL FLUID		

SHEET /7 OF 32 (A-119

BORING NO. 15-7

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	Overburden		9 0	2	밀비		Ξ	REMARKS
	Into Rock	9	S E			i iii	¥	
Total Depth of	y Boringincling	pedDeg	5 8	3	빌빌		2	
		3	BLOWS PER GINCH	RECOVERY/RQD	3 3	MOISTURE CONTENT	GROUNDWATER-FLUID	·
ELEV.	SOIL CLASSIFI SURFACE C			Ē	8 0	3	ਰ	
397	SURPACE	OVER	+-		+	+		
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1760 T	ATERIENE AT COLOR	FTION					_	
₩BOF2: ★ M	ATER LEVEL AT COMPLIATER LEVEL HOUR	S AFTER COMPLET	ПОМ			5	> -	PARTIAL LOSS OF DRILL FLUID TOTAL LOSS OF DRILL FLUID

SHEET 18 OF 32 SHI A-120

Project	W. T.P.		Instrumentation Installed									
Date:Start //	Complete/			tum for Surface El								
Location N	<i>E</i>			Т			92					
Drilling Agency		-		1	П	13	ΝĞ					
Driller		— <u>2</u>	•		11	3	ᆖ					
Drill Type		— È	#	1		5	: 5	LABORATORY RESULTS				
Drill Method		_ 2	2	0	5	JË	:15	AND				
Thickness of Overb		🖫	3	Į	要	wig	凹	REMARKS				
Depth Drilled Into R		_ š	5	5		2 اع	IJ₹					
Total Depth of Borin	g	- 2	1 0	1	u u	띠를	≧					
Dir. of Boring	VertInclinedD	8	BLOWS PER 6-INCH	RECOVERY/RQD	BAMPLE NUMBER	SAMPLE TYPE	GROUNDWATER-FLUID LOSS					
ELEV.	SOIL CLASSIFICATION		2	1 8	3	₹∣₫	12					
			-	1 =	8	<u>ه اع</u>	0					
346,9	SURFACE COVER		-	-	Н	1	╀-					
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361-	•				П							
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362-			1	1		1.	П					
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1 4				1 1		1	П	• •				
7.5							11					
365-		1				1						
1 7												
169-					1	4	П					
1 7		- 1		ll			П					
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MBOLS: WATER WATER	LEVEL AT COMPLETION LEVEL HOURS AFTER (COMPLE A 12				Ц	<u> </u> ;;	- PARTIAL LOSS OF DRILL FLU - TOTAL LOSS OF DRILL FLUI				

SHEET / OF 32 SI.A-121

BORING NO. 15-7

roject	NO	•	Insti						stalled
oterSteet /	/Complete/ /	•	Date						7
ocation N	E			1	T	T		_	
rilling Agency		.			-			1088	
miy Ayuroj <u></u> Mar	inspector	=	1	1			3		
III Type		Ī	1	I	ı		1.	DWATER-FLUID	
			동		L	1		린	LABORATORY RESULTS
		ည	Ž	9			토	Ŧ	AND
	vrburden	5		5	3	ш	18		REMARKS
	Rock	8	.5	≥	13	E	E	≤I	
tal Depth of Bo	ring	ı	6		ш	щ	5	ē	
	VertinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	BAMPLE NUMBER	BAMPLE TYPE	MOISTURE CONTENT	GROUN	
EV. 14	SOIL CLASSIFICATION SURFACE COVER	15	<u>a</u>	E	8	8	ž	8	
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ORL FORM 1202

1 June 1988

WATER LEVEL AT COMPLETION
ORL FORM 1202

SHEET 22 OF 32 SHE A-122

		Insti						stalled		
Project .		U, T, P. 	Surface Elevation Datum for Surface El							5
Location					T	1-				
Drilling .	Agen	ncy						3	LOSS	
Driller		Inspector	Z		1			£	1 _	
Drill Ty			Ĕ	X				E	13	LABORATORY RESULTS
Drill Me			2	2	۵	5		Ę	7	AND
		f Overburden	E	1 2	2	2	핕	Ιğ	1	REMARKS
		I Into Rock	8	E E	Ž	3	₹	W	Ş	
Dir of	ipur (Rosin	of BoringinclinedDeg	ಶ	9	Š	9	7	2	문	
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIQD	SAMPLE NUMBER	3	MOISTURE CONTENT	GROUNDWATER-FLUID	
ELEV.	DEPTH	SOIL CLASSIFICATION	Š	ā	æ	8	8	Ĭ	Ö	
306,4	یق	SURFACE COVER				Ц				
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- 5	4									
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YMBOLS:	V	WATER LEVEL AT COMPLETION					_		Ť	- PARTIAL LOSS OF DOUL FLUID
	-	WATER LEVEL HOURS AFTER COM	PLETIC	NC				;	,	- PARTIAL LOSS OF DRILL FLUID - TOTAL LOSS OF DRILL FLUID
RL FORM June 1988	1202	SHEET 27 OF 32 : A-1				R	0			NG NO. <u>(5-7</u>
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Projec	*	(4, T,P. // Complete//			ace um f					9
Date:	Start_	Complete	_	T	-11 P	1	ا <i>ل</i> ات ا			
		ngy				-			1088	
Driller	יעה ע	inspector	z					E		
			일	=				토	Ę	LABORATORY RESULTS
Drlll	Metho	d	5	S-INCH		5		E	뜻	AND
		of Overburden	E	9	ğ	9	삘	Ŕ	2	REMARKS
		d into Rock	Ş	뜶	١	3	Ξ	E	٤	
Total	Depth	of Boring	USCS CLASSIFICATION	BLOWS PER	RECOVERY/RIQD	SAMPLE NUMBER	삘	MOISTURE CONTENT	GROUNDWATER-FLUID	-
		ingVertinclinedDeg	8	5	8	4	3	810	3	
ELEV.	DEPTH	SOIL CLASSIFICATION	5	=	문	8	V 8)M	8	
286,9		SURFACE COVER								
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	75%	New Albany Shale,								4
	[<u> </u>	CHAILE A DI LA								E
	775-	3 AALE, Grown Glack To	- 1		- 1	1	1	ı	1	= = =
SH	4	SHALE, Brown Black to Black, Thinly Laminated, Soft to Medium Hard,	- 1	- 1	- -		1	1		4
-	72	Soft to Medium Hard,				1	1	1	1	
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YMBOL	7/1/2 T	WATER LEVEL AT COMPLETION				1			Ť	- PARTIAL LOSS OF DRILL FLUID
	Ť	WATER LEVEL HOURS AFTER COM	PLETIC	NC				>	3	- TOTAL LOSS OF DRILL FLUID

SHEET 22 OF 32 SHI A-124

BUI	WII.	IG NO		Instr						stalled	
Project		U.T.P.		Surface Elevation							
Dete: St	ari					1					
		ncyE							8807		
Drilling .	Ago	Inspector	Z	1				3			
Driller _	vne		은	=	1			토	5	LABORATORY RESULTS	
Drill M	etho:	1	3	1 2		5		삗	F	AND	
Thickne	33 0	f Overburden	Ë	1	ğ	9	M	Ŕ	巴	REMARKS	
		I Into Rock	§	15	Σ	3	Σ	Œ	×		
Total D	epth	of Boring	정	6		4	4	5	9	•	
Dir. of	Bort	ngVertinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT	GROUNDWATER-FLUID		
ELEV.	DEPTH	SOIL CLASSIFICATION	2	표	2	8	84	3	æ		
266,9		SURFACE COVER									
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SYMBOL	S : \(\frac{1}{2}	WATER LEVEL AT COMPLETION		.						> - PARTIAL LOSS OF DRILL FLUID > - TOTAL LOSS OF DRILL FLUID	
	1	WATER LEVEL HOURS AFTER CO	MPLE	HON					7	- TOTAL LUGG OF DRILL FLUID	

SHEET 23 OF 32 & A-125

		NG NO			rume					stalled
Projec	<u>. </u>			Surface Elevation						
Locati	on N	Compace		T	Г	T	Ī	T	_	
Drilling	Age	ncy					1	3	1088	
		Inspector	Š				l	1.1		
Drill Drill i		d	X	6-INCH		æ		色	ATER-FLUID	LABORATORY RESULTS AND
		of Overburden	Ē	3	8	8	ш	S	臣	REMARKS
Depth	Drille	d Into Rock	8	E	1	3	٤	10	I	
Total I)epti	of Boring	ठ	8	Ä	9	9	15	2	
			USCS CLASSIFICATION	BLOWS PER	RECOVERY/ROD	SAMPLE NUMBER	3	MOISTURE CONTENT	GROUNDW	·
ELEV.	DEPTH	SOIL CLASSIFICATION	5	ā	Œ	8	8	3	8	
2.46,9	420	SURFACE COVER	-			Н		-		
ŧ٠										
F	46/-									· · · · · · · · · · · · · · · · · ·
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F	42.									3
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YMBOLS	: 🗸	WATER LEVEL AT COMPLETION							>	- PARTIAL LOSS OF DRILL FLUID

SHEET 24 OF 32 SHE A-126

BOI		G NO		nstri Surfa						амеа
Project Date:St	ert	/ / Complete /	ı	Detu	m fc	v S	Sun	ac	E	
Location									888	
Drilling	Agen	icy	_					3	믜	
		inspector	2					F	믥	ARADATARY RECIII TO
Drill M		,	3	Ş		Œ			TER-FLU	LABORATORY RESULTS AND
		f Overburden		I	300	9	Ĭ	죗	틴	REMARKS
Depth I	Drilleo	i into Rock	7	EH	1V/F	3	Σ	9	≨I	
Total D	epth	of Boring	ᅥ	18/	VE	뿌	빌	2	呈	
		ngvertnamedpeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	3	SAMPLE TYPE	용	힑	
ELEV.	DEPTH	OOIL OCHOOL TOTTION	5	8	H	Ø	8	3	8	
2769	50-	SURFACE COVER				\vdash	Н		\dashv	
Ē	J 77 3									Core is Very Rad
E	481	·								From 495 to 509,5
ŧ	"	1								dur to bent Core :
E	482	·								Barrel The inversarest.
ļ.	7	1						.		would not late in per
E	483	·								-
F	"=									Wa cool
Ē.	187									Samph Depth Eiru
ŧ	"′=									No DAPTA EIRV
E	185								•	1 497.3 209.6 497.9 209.0
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E	466-									Z 500.9 2060 -
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E						ŀ				5 507,3 199.6
-	190									508.4 198.5
E		RADIARIA								6 508.6 190.3
Ė.	79/-	RQD In Runs 1.2 and 3 not				l				6 509.5 197.9
E	3	determined due to poor				l				
F	492	core conted by a heat				l				7 509.9 197.0 511.5 195.4
E5#		core coursed by a bent								
-	193									8 5/1/5 1957 -
E	3									51213 194.6
F	494									9 511.2 1946
E 01		11 1 2 16 6								5/3,2 /43,7
2/1,9'	115	Start 21/8 Core			_	\vdash	\vdash			0
Ę	3	- Broken Mech								- 1111
F	776-	much (New Albany Shale)		}		OY	1			2
14	=	much SHALE, Brown Black to				X	4			
5H 2046	497	much Black Thinly Laminsted			1	ľ	1/2			2055 0,0
2090		much Soft to Medium Hard,			1		0			Time
E	198	- Siltstone w/ occ Siltstone Lease			1					11/10-12/30
E	=	George spins) and pyrite nowhy			,	1				Left 2' of core in
F	199	pyrite			3	1				_
Ė		mech mad			1					Bot tom of hole 100 To Deill mater Kilung
SYMBOL		7- WATER LEVEL AT COMPLETION				_		-		- PARTIAL LOSS OF DRILL FLUID
	1	- WATER LEVEL HOURS AFTER COMP		TON		_				- TOTAL LOSS OF DRILL FLUID
ORL FOR		SHEET 25 OF 32 A-12	7			I	3()	31	NG NO. <u>6-7</u>
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		NG NO		instr Surfi				-		stalled
roject _		U, T, P, 		Detu						7
ets:Ster	T	E	$\overline{}$					_		
		ncy		1		-			8807	
		inspector	z							
			은	=				Ę	ER-FLUID	LABORATORY RESULTS
III Met			3	皇		5	П	E	5	AND
ickness	3 0	f Overburden	Ë	I	ğ	9	m	Š	Œ	REMARKS
opth Dri	illec	into Rock	8	5	٤	Ş	اځا	EC	3	
ital Dep	th	of Boring	귱		Ē	щ	щ	5	é	
r. of B	lorir	ngVertInclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	4	SAMPLE TYPE	181	GROUNDWA	
EV.	F	SOIL CLASSIFICATION	8	3	쁜	Z	3	2	ğ	
149	D D	SURFACE COVER								
50	00-	Mesh					П			Run Z Wayed Samp
	_ 1	- T+								Corrd 3.3 Zand 3
120	/4	Core Spin			1					Rec 1.5 100% Avill
	٠ :	-pyrite			1					LOSS 0,0 Water Retail
_ ا	4				3			- 1		
100	" 7	-Mich -Spin - Pyrite			29				ı	Time 12:45-13:15
ľ					10					Left 15 of Core in
50	17.7	-Siltstone Laminas			_			-		Rotton of hele
- 1	4	Mech Backer Mark						- 1	Ţ	R 3 Wayer fand
0	,, †	- Core Loss				- 1			- 1	Cored 6.3 4, 5 and 6
100	-	Lace Spin						Į	-	Coren on
	7	- Hader Sizz					-			Rec 4,95 100 To Orill
50	97	-Saia					- 1		-	LOGG 1,35 Water Return
	-4	COPE LOSS								Time 13/30- 14/00
72	E_{N}	-pyrite -pyrite nadaleş -Mech					ź			
۲۰,	Έ,	-pyrite	1	.	١ ١	Ì	4	- [-	Inner barreldida't
	3	= pyrite nodales		- 1	11		14	- 1	1	latch due to bent
50	거	- Mich			1	1	8		ı	
	4			.	V	-		- 1		Core berral consing
cos	5 4				60		- 1	- 1	-	Poor Lore recourt
- 1	4	-Core Spin Core Loss		- 1	2		- [-	and poor Love
776	,Ŧ	COPE LOSS	- 1	- 1	M		,	-	ł	condition core
7"	3	-pyrite				ľ			1	Condition Roda enlled
	3	- Core Spin		-		1		1	ı	Run 7 Core borre
770	4	- parte Mach					-	1	1	A
	3.	-pyrits					-	1	1	Cored 5,3 Fixed
511				- 1					1	Rec 5.3
r"	E	m /	. [- 1	0		-		1	L099 0,0
	4	- Mech	1	1	11					
52	4	- mesh	1		\cdot				1	Time 11:45-12:10
	1	prite and filts tone Lominar	J		Y				1	
5/3	4	ma./		1	1/0 8					100 % Doill water retain
27	#	Aprile			200	,				in Shole Drill water
	洋	Jefferson ville L'arstone		[,	01	1				Losges of turted to occur
P/7.	F				` ;	2			1	at endutran in
	1	574				1			L	Lints Tone
575	丁	AIR a sall last							1	Run 5
	1	- AlPopen Hydro Carbons								Cored 10,3
576.	3	-BIP Open present in					1			Arc 10, 3
1"	3	Jeffersonville, Ls								Los 9 0.0
	1	Sh Laniar BIPDOIS			0					
p77 -	1	- Very Agrillesing Porout Zonz		1	01				ŀ	Tine
2	+			1						12:30-13:50
578.	4	5/3/4 /933			1.				1	1011
70	4	7/23			14					
66	+	-5h Laminoz 3/31/ 171, L	.		0				1	•
579-	1	3h Laminac			0					
	#	54 0.01	1							
120	1	C+, INVIVI				L		Ĺ	1/	Orillwater Riturn
OLS:	77	WATER LEVEL AT COMPLETION	•						\	- PARTIAL LOSS OF DRILL FLU

ORL FORM 1: 1 June 1988

SHEET 26 OF 32 SH A-128

Project Date:St		//		Dett	ım f	or s	Surf	BCI	. E	7
Dete:St Locatio		E		T	Г	T-	П			
		cy						취	1088	
Driller _		Inspector	3			l	П	5		
Drill T			Į	7				SONTENT	FLUID	LABORATORY RESULTS
Drill M			길	Ž	9	NUMBER		팃	EF	AND
		Overburden		2	Ę	Z	퓝	8	٥	REMARKS
		I into Rock	ΙŠ	8	Ě	ĭ		뿐	₹	·
Dir. of	Borin	gVertinclinedDeg	2	2	18	Ţ	불	림	Š	
			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIGO	BAM	N S	HOISTURE	anou	
ELEV.	DEPTH	SOIL CLASSIFICATION	13	-	120	8		╛	9	
186.4	520-	SURFACE COVER	+	-	-		H	+	-	
	1-3	Limistone, Ten Brown to Library, Hard, Fossifirms								
	52/-	- BIP Porong w/Hydrocard	4			}	П			
	1 1	-BIPSh 0.01 Shloming:	1					ŀ		
45	522	Sh Lominas					H	ı		
	1	- Very agrilleous Black porons								
	١,,٩	Louisville Linestonz							ĺ	
-	23	4.4			1				į	
	الما	-BIP								
•	27-									
	3						-/1	-		
•	22	-Mech .			-		4	1	1	4 /
		- 11	1				1	-		Run C
•	24	_mech Geo	1				8	١		Cored 10, Z
	1 3	- Mech			i	١.	П	-	1	Rec 10,2
	527						H	-		
45	3	- Mech					П	- 1		Loss 0,0
	26-	-///						- 1		Time
	1							-		14:00-14:35
	29						1			
1	[- Mech Geo								
	$E_{n,n}$	- muhbro						-	- 1	
	٢٣٦		·		٠			1	١	
	5,7	- Mech Geo			0					
	73/-	11 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1			11	8		-		
	L. 3	Limes tone, Light braye	1			X		-	1	
•	772	to Gray , Medium Hard to	1		N	2				
	E	Hard, Slighty Unggy to				וכן		-	ı	
•	1933	Vaggy w/ Perous Zenrs,			100					
	=	stylolites, w/ oceshale			`			1	-	
•	<i>594</i>	Landan an And						-	-	20% Orill water
	‡	-mech Laminas or Bed w/						-	-	20% Vill Water
	232	occ stringer of						1		. Meturn
	1	-mach Dolomita	1		_				t	Run 7
	516								1	•
	7							I	1	Cored 10,0
	927	-mesh						ł		Rec 10,0
	7				0		1			L053 0,0
	ا رج	- 1010	1		1				-	Time
			1		1					· · · · •
	E	Mach			20					14:45-15:20
	7				00			-		H25 Odor
	_ =	4			1					Chanced Bits
	1400	WATER LEVEL AT COMPLETION	<u> </u>				_1	_1		

ORL FORM 120:

SHEET 27 OF 32 A-129

BORING NO. <u>(5-7</u>

ROKIL	1. 70		Instr		_				stalled
Project	U. T.P.		Surfi Detu						3
Date:Start	-		-	111 1	-	$\tilde{}$	~	-	
Location N_		ŀ			-			088	
Drilling Age		_		ĺ			3	=	
Oriller	Inspector	8					1		
Orill' Type_		5	天		_		温		LABORATORY RESULTS
Orill Method		<u> </u>	ĭ	۵	15		Ę	근	AND
Thickness o	of Overburden	¥		2		Ä	Ŗ		REMARKS
Depth Drilled	d into Rock	881	5	5	3	Ξ	EC	3	
otal Depth		7	<u>-</u>	5	m	ш	폭	6	
Dir. of Boris	ngVertinclinedDeg	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	5	ם	E	3	
		ည္ထ	2	2	3	3	ō	12	
LEV.	SOIL CLASSIFICATION)		2	SAMPLE NUMBER	8	3	Ø	
LEV.	SURFACE COVER								
540 -	-Meid SA Lamine , Odlite 0,03 aport							П	
1 3	-Mesh								
	-Mrch				П			П	
45			1 1		Н			Н	
9/2-	- AIP Open		, 1		ı				
69,5					H				
20	Porous to Very Porous Free								
775	-AIP Open						-		
45	Porous to Very Porous Zone -AIP Open Solution Ospth Elev					I			
-5 swit									
["]	- Vus 542.6 164.3 -54, 5526 1543	V		- 1		1			
	- 54 5526 1543 - 818 Solation								
575-	- BIP Sola Tion			- 1		- [- [- 1	
1 4	- RIP Open w/ xstoll - RIP Open w/ xstoll - Sty Popen Ventical Fracture			\dashv		- 1	ı	ŀ	Rung
	Sty Veeting Freshor					- 1	١	- 1	
546				- 1		- 1	١	- 1	Cored 10,3
1 3	BIP Shlaminac						ı		Rec 10.3
777	SALAMINAE			- 1		-1	١	- 1	•
['7	BIP Vertical Fracture			[1	1	- 1	Loss 0,0
1 =	Vertical Fracture	ı		1		21		ł	Time 7:30-5:30
5%-	Sh Laminez			- 1		1.	Ì		
1		- 1				Z	J	- 1	_
L.,-{	Sty Open Solution		1	- 1	1	0	١		20% Prillwater
879-3	-5tv			ĺ		١.	- 1	- 1	return
1	. ' .			- 1		- 1	- 1		181411
532	- Care Spin			ŀ	\dashv	-1	- 1	-	
				L	8	-1	- 1	- 1	
1 7	> BIP Open		- 1	ſ	1	- 1	- [Ay 5 Oder
55/-	BIP Opta			N	X.		- 1	- 1	
1 7	- 8/P w 14 1	.	- 1	4	7	-			
1_1	St. Sh. Laminas			11				- [•
32		.	- 1	0	- 1	-		-	•
74.7	= Sh 0.01 Sh Laminat		- 1	1	ı				
537	= Sh Caminas		- 1	Vol			Į		
F		- 1				1	ļ	-	
J	- ShLomina +	1	1	0			l	1	
59/	- Vag Mest	- 1	- 1	6	-1		ĺ	-	
; []		- 1	- 1		1		-	Ţ	
I		- 1	ĺ	1	ł	-		1	
22-1	-Mich Sh Laminar							1	
1 1			-	_			1	-	
53/	= Sh Lowing c				Į	ł			Run 9
	Sheminer Sheepiner Mech					1			Cored 10. Z
_	-(4. 311 010)		1	0				1	
757-	15H Loniges	- 1		13			1		Rec 10.2
a, E	-Sty Porous to Very Porous Zone			Y	1		1	1	60550.0
9/	· Vuc			1	\mathbf{I}	1	1		
538-	Dapth Elas	- 1		19			ļ		Tine 9:10-9:37
1 1	557,8 · 179,1 5(1,4 145,0	I	- 1	0	1				
5 57	561,9 145.0			12		1			20% Drill motor Retail
[[]]	-5+V	- 1		1	ł	ļ			
17	Billorn								H25 Oder
BOLS: ▽	WATER LEVEL AT COMPLETION						_		- PARTIAL LOSS OF DRILL FLU

Project		Wi T. P.		Surt	100	Εle	vel	, lon		
Date:St				Datu	m fo	Y S	Sur	ac	• E	7
Location		E				-			88	
Drilling	Age							3	2	
Driller _		Inspector	중					1	일	
	ype_		F	푱		_		盃	딛	LABORATORY RESULTS
	letho		5	6-INCH	2	BEF		Ŧ		AND
		of Overburden	<u> </u>	2	Ĕ	3	TYPE	8	뒥	REMARKS
		d Into Rock	CLASSIFICATION	2	Š	Ž	-	분	š	
		ngVertInclinedDeg	8	¥8	5	2	2	3	Ş	
ELEV.		SOIL CLASSIFICATION	8080	BLOWS PER	RECOVERY/ROD	Ž	SAMPLE 1	MOISTURE CONTENT	BROUNDWATER-FLUI	
146,4	DEPTH	SURFACE COVER		-		-	-	=	H	
11/11/7	160.	- BIP Open Solution							П	:
L .,		,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,								•
E45	36/-	-BIP Open Solation					l			₹.
F		TSTY Fort COO								:
145.0'	172	Lore Spin Sh 0.03'								•
E	[]	Sheming all 1 as 1							H	
ŧ		-Shlominas Shlominas Missh							П	i i i i i i i i i i i i i i i i i i i
F	563	5ty 5h 0.01'								:
F .									П	:
- 25	24-	- Sh Lamina + Mesh							П	7
E	:	- Mech					,			:
Ė.	365	Med & Sh. Laminar 0,03 apart			ĺ		ź			-
ļ.		Sh Laming Lamino &					1			
140.9	7/	-STY Mech			\vdash		8		H	Run10 =
-	1	-vag Xs tall					ľ		П	
<u> </u>	77	5h 0,040							П	Cover 10,3
F	577	5 x 2000							Н	Rec 10,0
E		Sty Open Vertical Fracture Open								Loss 0.3
F	568	2 Sty Open Core Spin Open							П	Time :
!	:	- Core Spin Open							П	
F	564	BIP Upon			l					4155-10135 =
E		חזקט אובו				۵				:
E	570=	BIPORIA				B				
F						X				:
F.	57/-	Vus Core Loss 0,2"			70	7			П	
E	-	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \			1	٦			П	Some Sections of -
E		- Vertical Fracture Open			0					Core will not pass:
F	772				/					Specs.
F.	- =	65h Core Spin Old Core Loss				-				3,0767.
-45	573	Lors spin vis cort Loss			20		П			=
-		Perous Zonz			1					* * * * * * * * * * * * * * * * * * *
Ė.	574	0.4			A					No Drill water =
F	:									Return for the
E i	7	- 5ty Opin 5660' 140.9'					Н			real of bear
E	-	- Sty Open					П		П	· • • • • • • • • • • • • • • • • • • •
F	0/=	,				П	П			:
E	576	-Sty Mech Shilaminac U.OI to 0.03' aport -Shilamings				Н				Run 11 :
E .		-Sh Laminas				H				•
F	3//_	-Va 5			0					lored 10,1 =
;	=	,			11					Rrc 10,1
<u> </u>	578-				/					Loss 0.0 -
E		-sty			20	$ \cdot $				Time 10:45-11:40 :
Ŀ I	577	- BIP Open Solution			2					
;					12				H	· :
F	500									:
SYMBOL	s: S	WATER LEVEL AT COMPLETION								- PARTIAL LOSS OF DRILL FLUID

SHEET 29 OF 32 A-131

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1 1	1		- 1	-	1		Cored 10-3
- 1 1							
				1		1	Rec Oil
	- 1			1			019 0.0
1 1		-	4	. J		1-	V17 V.V
			9 K	źl	ļ	1 7	Time 13/20-14/35
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	5	9			П		
	,	1			П		
	13	1					
		7					
1				ш	낵	_	APTIAL LOCK OF DOUL TO
OMPLETIO	N				>5	- T	ARTIAL LOSS OF DRILL FLU OTAL LOSS OF DRILL FLUI
MPLETIO 4-132	N	F	2/) F	>>	- T	OTAL LOSS OF DRILL FLUI OTAL LOSS OF DRILL FLUI G NO
	USCS CLASSIFICATION	USCS CLASSIFICATION BLOWS PER 6-INCH	USCS CLASSIFICATION BLOWS PER 6-INCH RECOVERY/ROD	USCS CLASSIFICATION USCS CLASSIFICATION Set 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	USCS CLASSIFICATION USCS CLASSIFICATION ON York Control of Market Control of Marke	100 7c 100 7c 1/0	100 % 100 %

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oject	U. T.P. Complete	_		lace um fi				E
estion N				T			Tan	
	ncy					۱.	100	
	Inspector	_ 2		i	ı			
II Type.	•	_ 9	-	1		١	: 5	LABORATORY RECULTS
II Metho		_ 5	호	1_	Œ		길	LABORATORY RESULTS
	of Overburden	_ 🖺	FINCH	8	18	ا ا	515	AND REMARKS
	d Into Rock	8	E	١E	3		1	REMARKS
tal Depth	of Boring	\$	4	5	Z			
r. of Bon		Deg	2	18	15	귄	:13	
EV. 🖹	SOIL CLASSIFICATION	NOTA SPECIAL SECTION OF THE PROPERTY OF THE PR	BLOWS PER	RECOVERY/ROD	₹	SAMPLE TYPE	GROUNDWATER-FLUID	
			-	1=	8	8 3	10	
6,4 8	SURFACE COVER		-	-	Н	-	╀	
	The same of the sa				П	1	ı	
(0)	- Solationing Broken		1					
601-	L.V.Z			1				
·	- BIP Solationingw/ Core Spin	- 1		1				
602	Core Spin	- 1		1	1			!
	BIP Solationing	- 1		1				
100	- BIP Solutioning Much	1		1	П		1	
103-	-Mich Mich				H			
	141				П			
604	- 2019 HON / 19	- 1			ll			
	- Solation Ing -BIP Open my xstall -Ung		1		Ιl			
Loc.	1 '				Ιl	1		
-	BIPOpen Solution	İ			П	ŀ		
					П			
64	-mech				П			·
	- Mech			\vdash	1			R 1+/
67	1							Runty
-	E 2 560.01 100 21 1	ı				34		Coved 9.8
		1				4		Rec 9.8
age	Mich				Ц	1,		
					8	8		Loss 0,0
209	- 8/P 00001				0			Time \$110-8:40
	T, 7	İ			X			11016 0:10-0:10
	1				7			
610			1					· · · · · · · · · · · · · · · · · · ·
3	Ls4. /				П			
611	-Sty -CoreSpla	- 1						•
5	· ·	. 1.		0.			П	
	= 5ty 5h 0,01'	`		13			П	
612				1				
	- Core Spin			$ \mathcal{A} $			П	
613	mech			00	`		П	·
	- SALamina + Mech			3,74			Ш	
2,,,=	5350.01°	1.		0				
6/9-	Sty			1			H	
=	-54"						11	•
65	-560.031				- 1			
	-510,03° -57y				-			
[,,,5								
616-	Sh Lamina = 5h Laminar Mech			\square	- [
	- Caminer Mesh				- 1		11	Run 15
47	- Corespin Sh Laminar Moch	İ						Cored 10, Z
3	Sheaming Moch			0				
1,	EJALAMIANY	- 1		1			11	Rrc 10,2
618-	-54	1		1			Н	4059 0.0
[]	= <i>5ty</i>	i i		10	\		П	Time 8:30 - 9:30
619				0			11	1,011 6:70 - 9:30
["]	0.0	1		0			H	
	- BIP W/ Shlaminar Mich	ı		١			Ιl	
16 207			1		- 1	1	1 1	

SHEET 3/ OF 32 A-133

BORING NO. 45-7

BO				instr Surh						stalled
Project .		u. T. P.		Detu						7
Date:St		_	_	T			F		_	
Location						ı		_	88	
Drilling		inspector	z		l			E	님	
Driller		•	2	-				호	5	LABORATORY RESULTS
Drill Ty	•		3	2		Œ	ı	里	드	AND
		Overburden	Ē	3	8		ш	3	ᇤ	REMARKS
		I Into Rock	88	4	E	3	3	0	3	
		of Boring	\$	4	5	2		Ę	ā	
		ngVertInclinedDeg	JECS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RIGHT	12	12	MOISTURE CONTE	3	
			3	2	8	1	3	ō	욷	
ELEV.	DEPTH	SOIL CLASSIFICATION		-	<u> </u>	8	8	=	0	
96.9		SURFACE COVER		⊢	-	╀	H	⊢	Н	
	w :	11 12 4 11				1		1	H	
		-Vaga Xstall -			1			i	П	
F	ω	- BIP Open				L		l	П	
E 1					i	ı				
E I	122				l	1	ı			
E. 1		-Mesh :								
E 1		- Mech scapzi						1	1 1	
-	<i>C23</i> -	- Mesh 56 0.03' - X5 1001' - X5 1011								•
<u> </u>		X5 to 11								
E I	674	Transition Zone		1		1				
		Very Agrilleons					١,			
82,1		Z					Z		1 1	V.A.
-	25	Wuldron Shale			1		1	l	П	
- 1					ł	1	8	1		•
- 1	625	5 HALE, Dark Gara		1						
: [=moch Medium Hord,		1		1			П	Run14 Palled
- 1	,,,,	Dolomitic								Cored 10, 4 Bettoni
5#	/27	-Mech				⊢	+			Cored 10, 9 per 100
F 1	-					8			П	Rec 10, 4 of lor.
- 1	18-	- Mech				0	1			
-	7					X			1	2099 0.0
- [29_	- much and Off size core			}	ري			!	- ,
F /	" ' 3	·				U		ľ	Н	Time
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	3	-mach Laminaz and Stubites								
70.2'	٤.,	B.O. H.							H	the designation of the special section (see Section 2015).
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SYMBOLS	: ₹	WATER LEVEL AT COMPLETION WATER LEVEL HOURS AFTER COM	IPLET	NOF					> 2	- TOTAL LOSS OF DRILL FLUID
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June 198		SHEET 32 OF 32 SI A	- 1 34	•			•	/ E	11	14 HU.

DATE: Dec. 10, 92 C5-1

break 2000 PAGE (vertical TOWNS CORE BORING NO. SR: Slightly Th ~ Vertical MB MB WEATHERING 3 کن ک 7 Z **5**W C_{λ} Ch v No MINERAL. 0 * Š CONDICTION 7 d ٥ ٧ * ** Open THEATMESS 45 + 4 4 M * 0 " 0 PROJECT NAME Polished ASPERITY 300 500 5 SR 3 m Sm 52 SR 5R Q 百 집 百 0 10 DESCRIPTION 150 900 0 50 O 0 0 0 o 0 0 ွ 00 001 ° 0 0 0 0 E Q Q Ū σ a ٥ Q a 0 σ 9 ۵ Q 9 σ C Q 506.3 496. 508 5/0 2/5 EP ELEV. TOP OF BOLK 506.3-506-72-503.95 506.73 494.05 -191.6-496.3 501.55 492.15 494.55 498.3 502.7 496.4 497.4 499.9 494.5 508.4 494.6 496.1 ¥1.00 501 495 505 509 RUNI W RUN 2 돌 RUM 9 N 3 커 8 4 જ 7

A-135

Dec. 10,92

DATE:

Plakes 3 walce CS-PACE shake tens REMARKS ۱۰ المنه دملار ١٠ CORE BORING NO. YELY GOOTSE Shale lens Shale Fossils 11 MB WEATHERING 35 S 35 S 2 CZ S CO W calcite Super 12 calcite calc. MINERAL. EXTICH 912 Ca/c No ν Ş No CONDICTION No 20 Ş ž 11 ٠, 000 Open Open Open TIGHTNESS Open 7 THE 3 mt PROJECT NAME Polished SILL R ASPERITY 5m 5.2 SR 512 SR SZ S N 2 Ø Ø Q V 01 OPERATION (5) 00 · d 0 °d 0 0 0 20 150 00 0 0 \mathcal{C} ٥ C S Q a Q S כ ط a Ы d a 異なた 536 745-526 ם 5/5.22 530.65 531.88 540.35 543.85 543.9 526.7 514.4 226 539.7 540.75 536 538 540 511.7 HE-80 3/6 543 2/5 145 RUN 4 RUN 5 RUN G P d 3 တ 3 0 4 18 S A-136

ELEV. TOP OF BOLE

DATE: Dec. 13,92

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		2	ွိဝ	SR	+~~	,,		CO	8w
	Ш	\vdash							
		2	00	SR	t u	۲۶	٥٧	00	shale lens
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- 11)	2	°	,	,	7	••	"	,

43

Dec.

DATE:

SENT 4 bick 2 2 2 C\$-ジボシ PAGE lens HEMORES in s 525 lens 412 lens CORE BORING NO. shale shale shale shale Shale Shabe علناها WEATHERING 3. 22 51,3 とい ンと 4 u * calc. MINERAL. ત્રુ No Calc. S **DREDKTICK** Š 20 " THEFTHESS Open tw mt 1 m mt 0 mt 0 0 W " 0 PROJECT NAME ASPERTY 3 km SR **5**R Q 2 DREATKTION .07 0 100 9 201 20 ° 00 20 0 (0) ° 0 0 0 E 2 Q 2 Q \mathcal{C} 2 S \mathcal{C} Q 2 S 2 2 2 2 S S S Ś 574 ELZV. TOP OF BOLE EDK 569.35 573.4 560.85 565.95 572.4 564.85 568.3 570.3 571.4 562.5 565.5 565.14 5.69.7 565.6 566.2 568.6 573.1 558.7 567.7 559 566 567 573 0 ž ž RIN 9 7 00 8 7 7 0 9 A-138

Dec 14, 92 DATE:

Broken - Crushed rock & Paylite shale lens, vertical Ward 5 Joint @ Shale - L.S. Interface greate lens (3/4 thick) 3 CORE BORING NO. C.S. 7:1shalle & wheite Shalle BAMBO lens calcite film Shalle lens Vens Callaite Shale Thir shale mB WEATHERED 2 5 35 35 SW 00 35 52 20 u aleite Parile Prit MENERAL. Calkite 20 ટ્ Ş νo 4 2 No THEATTHESS 200 200 Open + 444 mt mt * 0 0 1 PROJECT NAME ASPERTY 5R 38 26 9 W DRIENTATION 0 0/ 601 00/ 30° 800 45. 55° 300 0 9 0 50 2 ွ S 0 Ę C S 3 Q C J 0 8 8 S Q V S 587.8 594 584 ELEV. TOP OF BOLK BEX - 485 593.95 574-95 583.35 585 -8 586.3 588.4 4.685 576.3 590.6 591.5 592.7 579.3 582.4 583.6 577.7 579.3 584.2 100 587 592 589 574 567 590 Ruy 10 ğ 13 2 1 3 7 α 0 Ø

DATE: Dec. 42

NAME.
PROJECT NAME
HOLL
TO TOT
I
ELEV.

CORE BORING NO. CS-1	REMARK		Pyche residue & calcibe			912, shake a trace of pyrite			crushed rock filling						calcite	-	shale lens w/ colaite		shulle lens		Shalle less (V. Him)	an Shell		
-	WEATHERING	25	7	7	·	Un	7	7	٣٤	οN	"	m5	d.	4	~S √	Cn	5	SW	S	CO	00	00		
	MINEW.	No	Pymte			Pyrite	No	8		"	212	No.	¥	"	"	,,	,,	``	,		,	\$		
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C) C	TIEHTHESS	open	,			open	"	mt	0	1 m	mt	0	0	mt	0	tw	"	"	,	,	,	,		
PROJECT NAME	ASPENTY	R	7			R	"	2	7	"	"	u,	4	*	25	"	"	R	S.R.	"	"	"	٠	
β 4	DPRESTATION	400	50			450	50	.01	450	0	150	0 0	15°	"	03	"	300	150	30°	,01	150	.01		
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	JOHNT PER.																							
BOLE	ਮੁਤਾਰ				409-																+=			
7. TOP OF HOLE	ретн	593.05	593.3		- 465	544.5	514.95	595.2	595.5	1-965	596.4	2.765	396.5	597.15	598.3	593.9	.599.6	1.009	6,00,9	601.7	1 622.45	623.3		
ELEV.	JOHT PC.	151	7/		P. 13	1	8	3	7	٨	2	A-1	40	6	0/	"	13	73	7,	15	7)	11		

PROJECT NAME

4 CORE BORING NO. C5-1 Occ DATE:

shale lens PAGE ويري shalle REMARKS Crushed shale 8 WEATHERWO SW S 52 3 C MENERAL. No ટ્ર •• DOMESTICAL Š Ş TIGHTINESS w mt mt The tu tw 0 0 0 0 0 0 ASPERTY 500 56 SR B 8 " 07 DREMINDA 0 0 ,01 (2) 50 00 0 E V 2 ۵ J 2 Q a 11 ٥ S S 0 * 5 * 2 異なれ 615.5 ELEV. TOP UF BOLE BE 603 612.95 614.9 615.25 612.45 413.75 625.55 625-75 607.45 614.2 614.3 614.55 6.09.7 614.8 625.65 4. 707 607.3 8.119 6.113 614.7 611.2 613.3 603 100 HE-BO 608 RUN 13 12 N. 14 9 13 \$ 1 ∞ J 1

4

DATE: USC.

SATITOCUTA INTAC

Shelle CORE BORING NO. C5-1 lens PAGE Interface of 1.5. & HEMANING shele shalle 4 mm 2 mm WEATHERING ON 25 38 30 Sw CZ 5 **S** * ** S MENEW. 20 70 20 20 2 TIGHTHESS Open THE mt mt 0 0 PROJECT NAME ASPENTY 52 SR 3 Sm 3R Ø SR DRIENTXTION 300 2 150 0 0 0 20 2 0 a O a C C C 0 Q 5 9 Q D 質質に 630 5 625.5 630.5 ELEV. TOP OF HOLE ELEX. BoH & 625.54 625.5 615.5 629.4 621.05 621.75 619.25 621.3 4.779 628. 2 615.6 6/6.05 2.87 619.8 516.7 100 617.1 6/8 RIV 15 Runle 7 00

PROJECT NAME

ELET. TOP OF HOLE

DATE: 0-1. 21.42

UTP

CCRE BORING NO. CS-2

w/ calcite comenting w/calc. resid healed @ gray shake unweathered HEMANG broken Too wall [wertical 511-511.9 . 47 Ther mB WEATHERING Si 3 20 7 5 calc. Calc. Š MINETAL-20 ż ø CHEDICIDA 20 CZ Ë TIGHTHESS at ¥ 4 0 0 Sm ASPERTY SP 10 23 SS SIM 0 0 0 jo d 2 NOTIXTICINO 900 0 0 0 **F** ٥ 7 4 " ٥ * ۵ 1 量量 514.2 ang. 515.5 505.4 BEK 511.0-508.55 511.35 505.4-509.25 505.55 506.25 BERKER 510.0 504.85 507.3 502.75 503.55 511.9 505.9 507.9 512.1 506.6 503.3 507 501.3 502.1 FLED 5.00.8 500 Run 2 Run A CA

PROJECT NAME

ELEV. TOP OF BOLE

CORE BORING NO. CS-2 DATE:

		T	-				7	-	1		Ī						_									
2004	REMARKS	Broken rock		-			Filled w/ Coarse sand size	broken rock						Contact w/ L.S						V. thin shake vein			Shalle sem			Shalle sen
	WEATHERING	un	*	•	•	*	کد سؤ	***			20	,	"	5.0	u	"	•	•	"	Un			2℃	دي	*	,
	MINEUM.	с'n	,	,	`	,		*			pyrite	9	"	pyrite	pyrite	Nο	Parite	,	No	pyrik			<i>د.لا</i>	*	•	•
	ONDATION	C1~	,,	,,	,,	. \$,,	"			No	"	8	'n	٥	"	yes	"	No	•			10	,	*	•
	TIGHTHESS	0	+m	4	"	"	7	,			mt	"	1	,	1	4	8	•	*	,			+w	, ,	"	`
	ASPERTY	Sm	ld	Sm	,	"	*	,			5m	1	>	SR	"	R	*	,	1	,			R	7	Sm	,
	OPPENTATION	15°	.0	2	,	•	•	•			ဝွ	"	50	°O	50	150	"	.0	**	15°			0 ء	•	,01	,
	TPE	5	d	*	n	"	`	u,			О	d	ر ا	c.	2	っ	5	.5	၁	\$			Э	۵	"	0
	が数に		ليبيا	ا																				,	1	
	BEK									525.5												535.2				
	HLABO	512.65	513.2	513.4	513.5	4.418	515.15	515.45		515.5	5.77.5	517.65	5/8.3	519.3	520.5	521-3	521.2	522.85	523.4	524.35	_	525.5	1_	524.9	527.45	527.55
	JOHT									Run 3		A-1	44									R., 4				

DATE:

2-53

- Goded PAGE REMARKS CORE BORING NO. Very Vuggy 8055:15 1847 mB WEATHERING 35 5 7 S z 35 てい 35 35 3 3 3 3 5 Z 912 Cet 1 9 62. MINERAL. No .c Z • CONDICTION cZ S ¥ THEATTHESS + 4 7 mt 0 1 9 0 0 0 0 0 0 PROJECT NAME ASPERTY 5R 5 SR ď SR N NOTIVENEDRO °व 00 0 150 180 0 .57. 50 0 ° 0 0 5 E 2 2 2 ٥ 2 5 2 ၁ フ 2 2 つ 7 리 3 異なた 545.8 556 ED BLEV. TOP OF BOLK 552.13 555.53 552.7 547.35 547.85 548.53 548.73 548.9 549-6 535.8-550.7 545.8-547.3 544.15 544.65 545.4 550.1 551.7 546.5 551.1 553 551 537.3 Rin 6 A-145

DATE:

Jack C.5-2 Vuggy bottom HEMARKS Seam 35 CORE BORING NO. croded Shalle Shale WEATHERING 25 2 35 5.5 2 5 3 3 3 3 3 4 cale. Ca/c. MENEUM. 8 V 2 ٥ ٧ CONDICTION S 20 TREATMESS Tw 3 mt mt 0 0 0 PROJECT NAME ASPENTY 5 3 5R Q SR Q 5R Q Q v ય R 150 DPREMIXINGN 15. 0 0 150 0 0 3 153 153 0 · 0 0 ء 0 つ 2 つ à 2 つ 7 S 2 7 S C C 0 V S 'n ン 775 BER ELEV. TOP OF BOLE 565.15 562.25 564.15 564.8 565.7 562.9 3.495 560.55 361.59 8.175 555.85 559.5 563.3 556.9 558.8 563.5 554.85 554.9 555.3 556.4 560.1 553.4 556 **F B O** 554 Res 7 E d A-146

PROJECT NAME

		Scam	*	•				o Flakes				Season				-									
REMARS		2 min thick shalle	1 mm 1	*		shake scam		eroded & broken to	eroàca			4 mm Shalle se											JANKE BEL		
WGVTNETHU		מיי	•	u	SW	,	*	3	1	2.5	*	いつ	*	"	کر	•		3	nn	v			Un	5 ₪	,
MENEUM.		No		,	*		412	cak.	دكر	,	cake.	No	"	4	8	*	"	Calc.	200	,			مرد	`	•
ONDICTION		No	,	,	"	^	"	"	"	"	"	v	٨	*	4	•	4	"	•	*			0 کر	,	•
TIBHTNESS		mt	3	*	•	0	*	*	"	mt	u	7	•		*	•	"	0	t w	0			mt	,	٠
ASPERTY		5 m	"	"	8.8	B	ų	W	u	u	sR	5m	SR	"	"	R	u	v	"	SR			sm.	'II	8
оневлитися	·	150	~	001	"	150	: 01	°	253	,01	900	,0/	1	00	20	,0	*	5	051	5 2			°	"	00/
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F & F											- \ -				_	-	_			_	_	1.		1	Γ-
BEX	47/										1570.15	-										1486.7	1-1-	1	15
ниво	777	1000	2 // 2	×17 ×	6 177	4/9.4	26.2 45	26.91	269.4	6.678	66/5		477.0	241.50	×71.8	577.5	573	× 77. ×	274	514.		272		67/ CC	576.75
THICL	0.0	5 0.15									A-	147	<u>'</u>									20.0			

DATE:

CCRE BORING NO. CS-2

ELEV. TOP OF BOLK

DATE:

CCRE BORING NO. C5-2	WGATHERING REMARKS	ک ر		4	Un	ر الله الله الله الله الله الله الله الل	•	·	*	4			*	4	4	-	רט	S ک	un shale seam	S		Un	~	" 4 mm shalle seam	.,
								-									_					No			
	MUNEUM.	No	٨	"	"	*	•	"	"	"	"	"	"	"	*	*	*	*	`	"			*		"
	ONDATION	No	'n	u	•	*	•	\$	4	٠	*	v	ı	v	u	"	,	•	•	u		A No	u	•	"
Ð	MBHTNESS	mr	,	•	,	٠		0	0	mt	"	"	4	"	,	"	4	"	,	4		mF	4	*	,
PROJECT: NAHE	ASPERTY	3.2	٠,	7	*	•	R	38	*	*	"	R	sR.	•	*	. W	32	Sm	•	9		R	Sm	•	"
P8	NOTEXTRON	.01	,0	20°	(5,	,0/	50	.0	200	,01	4	0ء	٥	•	601	20°	00	601	*	00		200	(0)	200	\$
	- Ant	ρ	u,	5	7	ວ	5	n	*	"	•	>	2	ρ	7	O	*	4	*	"		5	ט	ρ	~
	AST P						لـــا																		
HOLE	e.Dr.																				+. 596.4				
TOP OF BOLE	НШВО	577.25	511.65	578.1	578.3	578.6	578.9	4.972	579.8	2.085	2.085	580.7	580.85	590.85	4-165	8.765	8.765	593.45	9-865	594.3	586-2+	587.3	597.6	588.3	589.2
ELEV.	JOHAT												14								Run 10	-			

PROJECT NAME ELEV. TOP OF BOLE

いいつ くない Shube Lews うちつ small. 1055 HEMARKS shale Swale shabe 227 -7.49 N WEATHERING Un 3,5 Cn 35 3 35 5 3 3 #2 35 Š ¥ 418. 20 MINEW. Ş 5 • ď, CHECKTION Ş ر ا 4 • J THEATTHESS tw TH +w tw 0 0 0 0 " ASPERTY 32 5/2 5R 0 28 Q 5R MOTIVATION 90 00 0 150 00 50 50 .01 00 S 50 P 0 S Э 2 2 S C 'n 2 5 • ·V ų 606.3 EE 624-43 596.4-600.7 603.3. 604.3 4.269 605.5 34.809 605.7 596.05 597.15 590.35 594.4 595.3 598.3 600.3 540.4 602-3 593.7 602 60,6 Run 11 A-149

DATE:

PAGE

CORE BORING NO.

DATE:

ELZV.	11	3012	PAGE E		H	PROJECT NAME			MINERAL.		CORE BORING NO. CS-C
덫		BEK	ii.	TYPE.	OPPENTATION	ASPERITY	TREATHESS	ACTACA	HOLLAZI	WEATHERWO	FEMARICS
Roll	626.3+	616.3									
	5.909			٦	15.3	SR	mt	20	912.	Sw	
	607			Ь	v.	`	*	٠.	'n	"	
	607.45			+	, 0	4	,	,	"	"	
	808			5	.06	*	•	"	"	Uη	
	808.15			d	00	5m	mt	*	وبكر	•	
	628.25			<u>م</u>	\$	SR	•	+	412	•	
	7.809			d	15°	*	•	,	•	5 W	
	609			5	*	8	"	1	"	•	249
	609.45			>	.0	R	4	1	cN	*	shalle seam (1mm)
A	629.65	017		Ь	06	5R	•	•		Un	
-1	2-019			a	15°	•	1	4		•	
50	8-013			ķ	٥٥	•	. +	*		•	shake seam (1mm)
	2.119			5	150	R	1		5	*	
	611.4			2	0 0	w 5	5	4	"	*	
	611.85		,	d	/5°	52	٥	u u	*	^	
	6:2.3			4	=	*	4	4	.,	•	
	612.5			5	/5°	*	4	4	u.	٠	shale scan (2mm)
	612.8			Ь	0 0	•	4		. "	*	
	613.4			*	• 0	"	0	¥	"	4	
	613-95			*	5°	5m	mt	,	"		Shake sum (1 mm)
	5.419			2	150	5R	*	,	,	4	3 8
	614.8		· · ·	V	. 5 .	Sm	u	,,,	~	"	, ,

ELEV. TOP OF BOLK

PROJECT NAME

2.5-2 ?AGE

CCRE BORING NO.

DATE:

colorization というつ منه Seam Seam HEMARICS Stam shalle shake Shalle shake shale £ green mm 2 WEATHERNE S 35 ž S 4 ø Ž Z 0 MINESWA. Š Ş DREDKTION 20 20 365 TREATMESS 1 mt 7 43 " 0 Q 3.50 ۶.۶ SR ASPERITY 2 m CANCED 10 512 36 SR 5R 5 R Q Q 150 NOTIXTICINO . 52 45. 30. , 0 0 450 0 Ö 50 40, ° 150 20 15 0 Ę \mathcal{C} J ٥ P σ V C SO d \mathcal{C} S Q V 5 8 異質 4.249 626.3 + 636.3 626.3 BEX 636.3-627.85 626.43 627.75 624.75 626.15 625.7 622.35 622.7 2.4.5 627.4 6.049 1.525 639.1 641.7 617.45 621.9 5.125 2.129 h · c29 618.1 6/6.3 624 THE CONTRACT Pen 14 Run 15 A-151

PROJECT NAME

ELEV. TOP OF HOLE

d ト つ

HEMARICS トシ WEATHERING SE 3 Z 1/ 3 1 W 11 11 11 11 W 1 Dyrite calcite 70. 50 MINEUM. W 11 20 **SECTION** Ź 1 11 11 1 1 11 11 u TIGHTHESS 00 00 at 1/ 11 11 0 ij 11 li 1 11 ASPERTY SR ā 1 0 1 22 1 " Q 집 10 11 OPPENDATION 1 11 0 ٥ 1/ 11 11 0 0 0 0 F Q d Q Q 4 11 // " 514 505 BER 526 . 5 504.05 503.15 504.75 506.01 501.43 525.53 504.3 7.4.2 505 85 5.7.7 504.1 501.18 500.63 507.2 500.9 501.7 502.2 505 500.4 499.3 505 502 HE DO Run Z A-152

CORE BORING NO. CS-3

DATE: Dec. 24, 92

DATE: 12cc 29-30 - 1992

JOINT CLASSIFICATION LOG

PROJECT NAME

CS-3 CCRE BORING NO.

rock Colored HOMMES Crushed Ú Green mB WEATHERING 25 ટ 38 S SE 35 11 3 4 // 3 5 5 1 5 20 8 5 shirt of 20 20 10 70 20 2 MINEW. 1/ 1 1 1 40 d 20 2 ٥ ک 50 20 50 300 20 CONDICTION ら、 5 1 1/ 90 OP OP mt 00 OP 00 TIGHTHESS 90 mt mtmt mi m tw CIO mr 1 Sm SR SR SR 5m ASPERTY ろな 0 1 1 0 0 O **OFFENTION** ŝ 400 150 20 00 1 ô ô • ô ° 5 ° 0 1 11 0 1/ E σ \mathcal{C} 0 Q 0 Q Ø \mathcal{C} S 2 0 2 2 Q 521-12+521-82 + 524.8 ELEV. TOP OF BOLE BEX 520.55 514.05 515.5 517.75 521.67 5/8.65 519:75 511.95 517.05 519.55 513.55 517.52 518.4 5:125 519.3 510.45 528.55 511.15 4.605 211.5 510-6 214 HL-BO 514 A-153 F C

DATE:

PROJECT MAME

ALC: U.S.

CS-3 shale vein CCRE BORING NO. 537 1 Shale > WEATHERING 2 50 S i 2 W 3 Pyrite MINERAL. No 3 Ş S • DEDICTION Ş 9 γo TREATMESS mt E mt 0 0 0 0 ASPERTY 5/7 SM SE SR Q DRESTRUCK ° 30° ° ° 0 ā 2 ۵ م ٥ 7 \boldsymbol{c} ۵ 534.3 + 544.3 524 - 534.3 ELEV. TOP OF BOLE BEX 536.32 529.85 527.3 523.75 526.2 538.2 522.45 525.6 524.6 525.4 523.6 521.9 E BO Riny Run 5 Rune F S A-154

CORE BORING NO. PROJECT NAME BLAV. TOP OF BOLE

					·	rock.										-		Se		(62)					
PAGE	PEMARG			Vugged		next ool broken rounded r	Vugqed			Vugged	1 mm shale vein	" " mm 2	Vugged	Fossils				Green coloring / shale	m B	very forous (vigged	mB				
	WEATHERING		00	, ms	,	U =	"	CA	υņ		Un	11	لبنو	رم	رب ج ا	'n	On.	\ \MS		00		CV	il	1	,
	MINERAL. CATION		υS	,	·,	1.	NO	,	"	· ·	,	,	٠,	``	,,	"	s	763	•	No		Ν̈́ο	**	"	"
	ONDICTION		No	,	7	"	,	"	"	"	CV	"	,	"	,	CN	"	,		NO		No	,	,	-1
	TREATMESS		tw	0	"	,	,	l tm	0	0	l tm	0	0	m +	>	,	"	0		m+		mt	. 🕦	,	•
	ASPERTY		R	"	"	5.12	7	5,2	*	3	,	3	R	,	,	28	5,8	1		R		Sm	*	"	5R
	OFFEDERATION		°01	0 0	1	,	20°	ا0ء	"	0.0	15,	.0	4	15,	,01	.0	30°	+		.0		0,0	´, ,	\$	1
			Ь	n n	n	ŋ	5	n	n	Ь	U	n	n	P	0	P	n	n		Ь		Ь	٦.	Ь	2
	原を			ب	اا	ال ال			لـــا																
	BEK	 554.5																							
	DEPTH	544.3-	544.5	544.9	545.2	545.3	545.4	545.4	246. J	27.745	5.745	547.12	2.TH2	31.845	549.15	2.645	50.055	550.3	520.15	1.155	551.7	554.35	525.65	553.17	553.45
	JOHT	Run6							·		A-	15	5												

DATE:

CS-3 Lein REMARKS CORE BORING NO. shale WEATHERING **SE** 2 S MENERAL-LENTION 20 CONDAINCE S Ž TREATMESS t u mt 0 m 0 0 Ċ PROJECT NAME ASPERTY Sm 5 R 5R 200 26 5M SR 5R OPERATOR 0 15. 150 0 ô 3 3 5 9 c3 2 2 554.4-564.4 BE ELEV. TOP OF BOLE 555.45 555.25 555.7 556.33 554.75 556.1 553.95 553.65 553.85 E-80 Run 7 MG A | | A-156

CS-3 CCRE BORING NO. PROJECT NAME ELET. TOP OF BOLK

(n-1469) HEMMERS くらく crystals Shale WEATHERING 35 5W Sw 3 3 5 3 5 " ** crystl. S 20 MINERAL. No 912. 912. δŞ So CHOCHON S S 20 THEATTHESS The tw mt m 0 9 E 0 00 9 " ASPENTY 200 SR SR Q 5/2 V 2 DEPENDANCE 38 150 150 0 30° 0 25° 100) 15. 0 200 ° ,01 2 <u>K</u> 0 9 \mathcal{C} σ 9 CN ၁ 9 Éğr BEK 563.15 563.4 559.65 560.55 563.7 564.1 561.95 559.35 562.3 556.5 560.1 561.4 558.8 559.3 561.9 562.7 557.6 HE BO 561 557 F 강 A-157

PROJECT NAME

ELEV. TOP OF HOLE

(0493ed) いなっ Shalle vein shall vien PAGE Printe shale \$//من Vugged walks REMARKS shale Ç. Vagged 4 mm * Some trace WEATHERNO mai. W 52 3 3.5 52 50 2 3 .3 Pyrite Pyrite MINEUL. 5 Š 3 CHECTION Š " 11 " 11 " " TREATMESS 0 TW 0 m tw ASPERITY くろ SA SR 22 210 Sm 200 SR Q d V OPPENTATION 0.0 30. 25° 45. 200 0 ° 3 9 0 4 F 2 c2 > 2 0 ٥ ۵ 2 S 2 S 574 EEK 573.15 572.65 572.15 27.895 510.6 571.65 567.95 569.02 589.55 564.9 547.75 549.47 564.65 564.95 567.15 2.875 564.8 564.4 566.1 565.7 HL BO 571 Run 3 A-158

C5-3

CCRE BORING NO.

DATE:

6-57 PAGE CORE BORING NO. PROJECT NAME ELEV. TOP OF HOLE

Left wall Lis., Right is shalle **L.**S. shale vein Joinhed 1eft wall shale, Right middle shale REMARKS quarte lens at its Some WEATHERING Ş 5 S 3 35 $\tilde{\mathcal{J}}$ " 3 No MINEUM. 20 11 11 CONDICTION ٥ ٧ No TIBHTHESS Z mt M mt0 0 0 0 0 11 ASPERTY 52 SR 5R SR Q α Q " DREATATION 6 10 3 200 0 30° 0 150 5. 5, (2) 300 2, Ö O 5 10 F 2 2 NO 2 c۵ 2 0 2 0 Φ 9 Φ **3** 0 0 5821 + 583.9 -582. BEX 583.8 582.95 583-55 581.35 581.85 582.4 578.55 519.05 580.05 573.75 580.5 580.8 581.5 576.35 577.72 578.4 579.9 574.37 579.5 575.4 577.2 578.1 E 574 576 Pur 10 Ring A-159

ELEV. TOP UF HOLK

shulle lens wil fine fragments 2 mm thick stripe vein いけい といり くいつ しらい 65-3 PAGE Sheele Sheek snake **FEMORS** Shale Svale CORE BORING NO. 3 mm thick おいっと 2 mm 4 mm WEATHERING SN S CS 35 S Sw S Z CZ 3 No MINEUM. Ş Š " NCH2000 20 NO TIBERTHESS tw T tw tw mt 0 0 PROJECT NAME ASPERITY 50 53 23 Sm 2 2 200 2 Q d d Q Q DRIENTXTICH 300 20. 150 0 30, 15. 2° 30 5 ° 400 .0 0 ° 0 00/ ° ၁ 2) S Δ ٥ S 0 2 cS 4 S C C c601.5 +624.3 EE 594 595.75 599.65 596.95 597.65 593.55 600.02 5.109 583.4 588.25 541.85 4.009 584.45 584.75 592.2 584.7 242.7 5.985 544.6 597.3 294 593 599 109 A-160 R:011 돌

ELEV. TOP OF BOLE

PROJECT NAME

CORE BORING NO.

DATE:

C S- 3 PAGE くさら (243) **FEMORS** Shalle Rock croded Crushed eroded ~~~ 2 WEATHERING S Se 22 ະ້ວ 3 * ** W MINEW. ر د δ ک ن 917 CONDICTION S σ 5 v 4 TROUMESS m mt mt tw mt M 0 0 u 0 0 0 0 0 ASPERITY SR VR 5/2 22 Ø 4 ¥ DPREATTON 0 400 909 250 30 3 150 0 450 00 15, 0 0 ų, 1, 3 c9 Q V) S S ŝ 9 S C a 0 0 Э S a ۵ Ś 異類に 602.6 4614.3 ğ 611.15 54.209 603.4 612.05 612.35 607.05 413.85 602.55 502.7 608.15 22.00 601.85 6.019 503.5 7.509 2.209 607.3 603.4 604.2. 608.7 209.6 605.1 613 6 A-161 ğ g

DATE:

CORE BORING NO. PROJECT NAME

Shalle lens separated on Stam Start CS-3 Broken by shilling shale shalle Paces 2 mm Shalle 2 mm mB both WEATHERING ະີ ર્ક ຕຸ CC 50 MENEUM. Š Ş Ŋ * W CONDICTION Š 5 مرم Ş 4 I, u TIBHTHESS mt411 mt 0 * 0 0 ASPERITY Sm 5m sm 23 Sm Sm Sm SR SR 10 d 20° **OPEDATION** 5 £ 57 200 352 50 250 o Vi 250 5.0 00 ሪያ 0 'n Æ ٥ 0 2 ٥ ٦ 0 ۵ σ 2 ş \mathcal{C} 4 11 626-14636.3 626. 2.412 BEX 217 ELEV. TOP OF HOLK 631.42 630 - 72 59.279 620.55 625.3 2.627 615.05 615.55 615.75 6.819 5.425 614.8 615.5 6/6.55 614-3 9.419 C15.7 614.3 **E** 919 Run 14 S/ CA-162 Rin 14 Ä

DATE:

c S-S PAGE CORE BORING NO. PROJECT NAME ELEV. TOP OF HOLK

lens shale WEATHERING c_n MENEW. No CONDICTION γ° TIGHTNESS +-m+ ASPERTY Q OPENTATION ° E PE S 風風 636.3 + 639.45 BEK 638.1 R:017 MG. A-163

ム レ フ PROJECT NAME

CS-4 CORE BORING NO.

DATE: Dec. 15 ,42

clay filling w/ fine crushed rock side wall مُرُو HEMATICS ఞ ودم lens cky bed W B mB MB Pyrite clay 25 WEATHERING 52 35 S CA 5 . 4 " Š MINERAL-ટ્ CHOKINON 2 20 200 Open TRACTICESS 000 open 200 Open 13 0 4 5 m 3 Polished polished ASPERTY Sm Sm अ 11 **OPEDATION** 7.5 (o ° ô Ø 1 ے 2 ۵ C 505.3 499.9 9. 666 515.3 ED. ELEV. TOP OF BOLE 499.2 -499-5-499.7-502.25 505.3 -503.05 506.15 4. 666 500.95 503.85 505.33 503.4 505.35 526.85 507.5 503.7 500.4 506.3 507.3 504.6 505.9 506.7 4.105 500 **E 90** RUN 2 C.V. 9 4 7 7

PROJECT NAME ELEV. TOP OF HOLE

.05 parite L.S. Stratum starts at Asp wall C.5-4 Shalle Parite هر will FEMARICS between lens 5 Parite 520.2 Trace 15.25 MB 8 mB WEATHERING 55 c C S 20 MINEM Š ર્ટ્ર Ş NOILY000 20 50 TIGHTHESS 4 + 5 سر ک +3 ž m 0 0 0 W 0 0 ٥ 0 9 ASPERITY 3 22 S 5.6 5m 5m 5R 집 á DRESATION 150 0.0 ું ° **°** 0 0 0 E *'*2 ٥ 2 Q 2 0 ٥ 0 σ ٥ 2 Q ۵ ٥ 515.3+525.3 EDK 520-85 518.2 517.5 518.9 514.85 516.2 515.3 5/9.8 509.35 510.8 513.4 513.9 510.3 4.215 512.7 514.1 FE-80 511.2 514 Run 3 돌 A-165 2 13 9/ 1 òo 12 ~ 14 7 =

DATE:

CORE BORING NO.

Stem shale વ S 521.3

PROJECT NAME

ELEV. TOP OF BOLE

(5, of shale Eraded J 912. Crastals CS - 4 į. ker? lens / seam 34 coloring HEMANIES Shale scan CORE BORING NO. colcite Pila 100 shale Shelly 1.5. green Shale Chenejing ナナー WEATHERING 35 . پ 5~ こと 2 5. ? CJ **S**~ ca/cite MINERAL. Pyrite Š 20 ઝ્ ° 2 2 915 Ş ONDICTION S γ ર્ટ 20 ٧ Yes THEMMESS TE +4 m +4 100 + 0 0 0 0 0 0 0 ASPERITY 38 28 28 58 5m 22 0 8 Q DRIENTATION 25° 1,2 30° 300 1301 ွဲ 0 ° 5. 03 \sim d Ō E 2 σ ۵ C 2 2 0 3 S つ S 0 ÉEr -535.3 545.54 555.7 535.3 + 545. e e 525.15 530.55 544.45 526.15 539.15 551.65 572.3 248.6 549.4 5.055 5.53.3 527-8 1. 4.25 526.6 544. 551.3 551.2 HE-00 550 547 A-166 R. v. G R~4 F 12 9 1 56 ω 7 +

PROJECT NAME

SLAV. TOP OF BOLK

DATE:

11.ck CS-4 Stam 50 Shale REMARKS 1005 26 Shale shale <. * Him shall e Shale WEATHERING 5 35 38 22 SE 35 Ş • calcite MENERAL. ટ્ર Ş **ACITACIDO** 20 S TIGHTIMESS TH mt te 0 d 0 0 0 0 0 ASPERTY SR 22 52 Q ď C X NORTHANDRESS 120 150 5. 30° 150 123 · 0 S. , 9 0 5° ွိ Ô ٤ σ J C S **√** 2 ٥ ۵ 3 S d Φ ۵ ۵ 2 555.7 + 565.8 560.85 564.05 555.75 558.3 . 6-755 557.4 541.95 551.75 555.8 4.255 553.5 553.7 555.3 558.6 562.7 562.4 554.4 5.755 561.6 HE GO 555 56 A 527 554 5 17 d | ... 3 3 13 14 4 = ~ Ŧ ó 71

CORE BORING NO.

PROJECT NAME

ELEV. TOP OF BOLK

CCRE BORING NO. CS - +

1923 6 5601 at botton Seem REMARKS 8 から からない Semm Shale lens shalle lens Shele Shale Strale shalle WEATHERING SW S **5**√ 4 SE 25 40 2 35 מע Un W MINEUM. Z Ş S **DOMONTON** δ Z S V TREATMESS Ŧ F Ì 0 T 0 4.0 ASPERTY SR 200 7 SR. SR 58 SR 11 9 V α " 8 OPENTATION 150 400 30 0 5 ° ° ° 5 Ę 2 Q 2 ۵ S ວ Q 2 9 Q 2 S 7 \mathcal{C} 5 586 576 ER 51.72 582.85 570.35 572.15 573.95 574.75 578.75 583.6 572.4 547.45 575.5 578.7 580.8 565.8 566.35 8.795 2.875 5.725 581.3 565.2 580.1 **FE-80** 576 573 Run B Run 9 0 2 A-168 8 4 2 3 7

DATE:

C5-4 CCRE BORING NO. PROJECT NAME TOP OF BOLE ELZV.

crystals Unggy Broken neck Broken rock lens 1625 w/ quarle len's Broken rock Scam HEMARKS Shale Shale shale Shale -m-2 WEATHERING \$. 3 S C S 5~ 2 20 Ş MENERAL. 915. Š ર્જ DEDICTION Š 20 Z TREATMESS m 2 9 Ī 0 9 9 ASPERTY 26 53 53 SP SR 5R V Ø OPPENDATION الم °2 20 ° ·Q 'n ć တ " **F** 9 J) ٥ \mathcal{C} Cc2 S S 2 2 S 2 2 S S 596.3 - 606.4 596.2 ED 603.55 605.5 598.65 501.35 64.15 59.3.85 605.3 588-75 591.3 597.6 601.2 8.409 590.3 591.8 585.4 584.4 596 DEPTH 586 589 ⊸ A-169 ລ A A 0 =

Crushed rock at both wall 8.309 - 4.809 MOON F-50 9/akes Jam PAGE FEMARES Umg 177 Jalls Core breaks Unggal @ botton CORE BORING NO. deteriorated Mandling Paked V-311 WEATHERING 20 لىرى S S 5 5 N 55 • " 11 MINEUM 246 Ş 7 No 415 CHOCHOK ž 50 TIBHTHESS mt 7 E 0 0 T • 0 d 0 PROJECT NAME Polished ASPERMY SP 3 d 36 Q Q α **OPEDATATION** (0) 0 ွ 00 õ ŝ 4 ٥ 2 Q 0 9 9 σ 0 9 S 2 a つ V 9 9 ğ ğ t 59.719 1117 BEK ELAV. TOP OF BOLE 614.65 74.809 611.55 -615.65 6/3:25 606.4-612.65 608.05 8-609 T-019 612.15 612-35 613.8 607.3 8-8-9 611.2 609.4 606.5 + • 809 8.119 1.017 E CEPTE 1.119 Ru 12 S 7 7 2 11 11 15 2 ર| A-170 3 B = 2 ω V ω

C5 - 4

CCRE BORING NO.

DATE

ELEV. TOP OF BOLE

Ø shale flakes PAGE lens PENAMES lens * • Shake Stake Shale 3-4 mm m B mB WEATHERING 2 55 2 2 2 " MENERAL-IZATION Ŋ Š S ۸ CHECTION Ş Š Ş TREATMESS tu tw T ASPERITY 500 33 23 Sm d 5R N 23 Q OPPENTATION 15 10 203 10 1001 001 150 150 0 ° F C. ۵ \mathcal{L} 2 S $\boldsymbol{\mathcal{C}}$ 2 2 D ۵ d S 616.7- 626.85 626-85+636.75 B2HQ 636.20 4.113 BER 617.35 -624.45 634.6 620.25 624.35 622.85 621.55 6:4.2 619.7 628.3 616.3 616.55 614.3 622.1 **E** 1.117 513 R.v 13 R. 4 14 NO. 23 22 3 ß A-171

Appendix B Rock Test Results

Table 4.1a

Summary of Laboratory Test Results for Borehole PV at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS JULY 30, 1991

			# 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			***********	*********		***********	*********	***************************************		***************************************	***************************************			
													•	SONIC VELOCITIES (FT/SEC)	TTIES (+	1/SEC)	
				AXIAL	YOUNG'E			•	NEASURED					LATERAL	LATERAL		
COTP.	DEPTH (FT)	etev (3)	STRENGTH (PSI)	STRAIN AT FAILURE (X)	\$000 X E08 C+81)	DEWS177 (PCF)	CONTENT (X)	CALCULATED POROSITY* (X)	PORCETTY SPEC PERH ROCK AXIAL AVERAGE DIAMETER (X) (X) (M) TYPE AXIAL AVERAGE 1/4 1/2 3/4	SPEC	768 80 80 80 80 80 80 80 80 80 80 80 80 80	ROCK	AXIAL	AVERAGE	, 4/4	DIAMETER 1/4 1/2 3/4	3/4
747	17.8-		1100	3.10	0.03	155.4	5.6	12.8				SKALE	7600	8200	888 888 888	22 22 23 23 20 20 20	850 850 850
224	22.72 27.1		1000	3.93	0.05	155.9	9.6	12.7				SKALE	7600	8100	8000 83000	8200 8100	88
200	37.0		8	3.93	0.02	155.7	6.2	13.0				SKALE	7600	8200	8000 8000	8300 8200	8200
25	25. 42.		200	4.12	0.01	154.8	7.2	14.3				BHALE	7300	7800	82 80 80	7800 000 000	28
8 28	5.5 6.5		80	4.00	0.01	155.8	9.9	13.3				BHALE	7400	7900	88 22	7800	200
794	67.1- 67.1-		200	3.24	0.01	157.0	5.7	4.9				SKALE	7600	9099	8800 8800	8500 8600	8700 8700
***	EE Ģņ		1000	2.98	0.03	158.6	5.2	10.5				SHALE		0069	944 9000 9000	0009	8800

^{*} ASSUMED VALUES OF SPÉCIFIC GRAVITY WERE: SHALE * 2.70 (2.60 FOR NEW ALBANY); LIMESTONE * 2.71; DOLCHITE * 2.82; SANDSTONE * 2.65.

Table 4.1b

Summary of Laboratory Test Results for Borehole PH at the UTP Portal Area

FORT KHOX, KENTUCKY - ROCK TEST RESULTS

						JULY 30,	JO.		1991			***********	*********	***************************************			
										·			ā	SONIC VELOCITIES (FT/SEC)	ITIES (F	1/SEC)	
									HEA	MEASURED					LATERAL		
TIANS	REACH	FLEV	UC	STRAIR AT	MODULUS MODULUS X E06	VET	CONTENT	WATER CALCULATED	POROSITY SPEC	BPEC BRAV	FER	ROCK	AXIAL AVERAGE	AVERGE		DIANETER	
ŝ	(LE)	(F)	(184)	8		(PCF)	8	(X) (X)	(X)	X)	Ê	1/4 1/2 3/4		***************************************	×_	1/2	3/4
PH17	7.5		8	1.61	0.05	158.3	3.4	10.9				BHALE	8500	8300	8600 6200	0000	7900
P.K26	27.0		1100	1.70	0.01	158.0	4.9	10.6	÷			BKALE	0098	0098	8300 8900	8008	8200 8800
PIGS	32.3		1100	1.33	0.00	159.8	4.9	9.6				BHALE	9009	9009	8500 8600	8700 8800	8200 8800
P#44	11. 11.		1200	1.43	0.0	150.7	6.4	10.2				SHALE	9 200	8700	800 800 800 800 800	8500 8500	900 800 800 800 800
PH66	33 4		1200	1.20	0.10	150.0	4.5	9.6				BHALE	989	8900	8800 8900	8500 8500	900 800 800
PH69	69.2- 89.5	•	000	1.45	90.0	158.4	5.1	10.5				SHALE	6400	9100	8200 8800	8100 9000	8 300
PK101	101.9-		1000	1.55	90.0	159.5	4.5	7.6				SHALE	000	0004	8500 9500	8500 9600	9200 9200
PH121	121.7-		909	2.62	90.0	159.0	5.1	10.2				SHALE	870	8900	8500 9200	8700 9300	8700 9200
PH145	146.2		1000	0.60	0.14	161.5	4.3					SHALE	920	9200	9700	9500	0076
P#160	160.0		800	1.36	0.09	159.6	4.5	ę. 8				SHALE	6600	9700	9300	9800	9700

B-4

- ASSENCE VALUES OF SPECIFIC GRAVITY WERE: SHALE - 2.70 (2.60 FOR NEW ALBANY); LIMESTONE - 2.71; DOLONITE - 2.82; SANDSTONE - 2.65.

Table 4.2a

POAT ENCH, PENTUCKY - BOCK TEST RESULTS MAY 6, 1991

														BONIC VELOCITIES (FT/SEC)	2 2211	1/460)	
										PEASURED				LATEUL	LATERAL		
		2	3	AXIAL STRAİN AT		5	MATER	CALCARATED	PORCELTY SPEC	2	Ē	ğ		AVERAGE		DIAMETER	
3 0	E	£	(PSI)	A LURE	# C C C C C C C C C C C C C C C C C C C	(PCF)		(X) (X)	3		Ē				٤	2	×
-	13.	35.	86 80	r	0.35	199.3	4.0	7.				STALE	1000	11800	55	86 22 24 25	88
:		207.0							7.4	2.76							
. 8		2.5	٠					,	:	1.7							
~	22		88	1.67	0.63	160.4	3.6					BUNTE	10600	180	88 ==		11500
2	1	147.3							10.1	2.7							
=	200.0	477.0							4.4	2.7							
•	215.0	e e	4580	E.	6.3	4.6	4.0	3				BIALE	8	8	88 ==	288	88
5	210.9	467.0							4.0	2.78							
	2	457.9							•	K.						1	
•	25	. 20.3	999	2.	0.30	163.0	3.0	6.5					10500	8	1300	88	22.08
5	97.6	2.83							1.4	2.7							
2	7.0%	5.15							1.7	2.76					•	•	
-	67	3.5	0087	3.	9.14	161.0	;	7.7				STALE	1000	200	250	800	882
=	3.65	427.3							4.0	F.7				•			
\$	2.68.1	417.0							 	2.76			1		3	:	5
•	EE.		3400	2.10	0.13	161.0	0.	~					3	3	<u>=</u>	200	1500
=	278.0	407.1							 	2.7							
Ā	2.00	396.7							5.	2.7			3		. 8	-	12000
-		130.6	8	1.74	9.1	4.6	3.7	2					3	3	8	12100	12000
Ē		347.0							:	7.7						-	
\$	306.0	377.0				•			~	2.78			-		5	1200	9935
•	316.5	33	28	P.	2.31	161.0	w.	3					3	3	8	8	<u>&</u>
25	316.9	347.0					CALESTA !	10.5 2.60 40 are any algants: Light for 2.71 polonite = 2.62; sandstone = 2.65.	- 2.71: P	2 7 8 7 8 4 8 4 8 4 8 4 8 4 8 4 8 4 8 4 8	2.62, 8	ANDSTONE .	2.63.				

138 318.9 367.0 10.2 MARE MANITY VENER BALLE = 2.70 (2.60 FOR NEW ALBARY); LIMESTONE = 2.71 DOLCHITE - ASSESSE VALUES OF SPECIFIC MANITY

Table 4.2b (page 1 of 2)

FORT KNOK, KENTUCKY - ROCK TEST RESULTS NAY 6, 1991

					-												
														SONIC VELOCITIES (77/9EC)	- •	E9 (71/7EC)	
										KEASURED				LATERAL	LATERAL	1	
		2	•	AIM	TOLSIA'S		LATER	CALCULATED	POROS I TY	2	30	100				PLACTER	
				36	× E	E (DE)	S S	CONTENT POROSITY*	8	A A	Ē	1	AKIAL	AVEMA	*	ζ	š
:		1							0.4	2.80							
: :	9 84	184.1							:	2.7							
· -		Ē	97	1.2	2.0	160.6	3.0	:				SHALE	28	12000	904 	22 22 20 20 20 20 20 20 20 20 20 20 20 2	<u>‡</u> ‡
		218.4							1.	3.74							
2	14.e	13.7							: :								
;	¥.	345.3						,	?								976
* .			83	7.8	9.1	14.5	•	2				ERALE	8301	3	22	220	2
5	355.0	24.3							•	2.5					•		
4	7	245.0							4.4	£.7							
	7.00	3	280	8.2	0.10	11.4	4:	:				BENTE	28	12300	<u> </u>	117 882 883	
ŧ									10.1	2.81							
: :		7.40					•		:	2.7							
: -	i	200	4300	£.	0.21	1.121	3.0	7.7				STALE	10.00	12800	22 25 25	\$ 15 20 20 20 20 20 20 20 20 20 20 20 20 20	27 20 20 20 20 20 20 20 20 20 20 20 20 20
	286.8	20.5							7.5	2.7				•			٠
\$	ž	3.51								2.7							
7	Y.Y.	314.9												٠			
3	- 4	200								2.77							
3	£64 -:-	×.										*****	900	12700	12800	12800	12500
•	\$5.5 \$3.5		900	r.				3							2002		
3	419.1	27.2							6.5	2.1	•						
2	124.1	23.2							7.2	2.7	•					•	
2	13.4	7.02							1.	2.7							
:	7.027	280.5				160.8	;	:							•	•	
1	1.3	23.2							5.9	2.7							
3	43.8	2.57							7.5	2.76							
	4.5.4	246.5								2.38							
ł																	

Table 4.2b (page 2 of 2)

PORT EXICAL, KENTUCKY • ROCK TEST REBALTS
(MAY 6, 1991
(continued)

														SOUTE VELOCITIES (FT/SEC)	8311 1	77/MGC)	
									ğ	MEASURED				LATEAL	LATERA	_	
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(C. C.	E	(11)	(Jaj		ŝ	ŝ	8	8	ε		ĝ						
		247.0					•			2.18							
8 ~	150.2	29.1	13900	1.6	#.	139.2	1.2	18.4				CARBON	24	12700	<u>7</u> 2	<u> </u>	<u> </u>
	7.057	7.73															
2	1.83	24.2								3 :							
E	.	273.3								3.2			1				
•	2.5	77.7	67	5.	9.8	143.1	1.7	13.4				TATE OF	2	3	2 8	3	3
2	, KY	24.3				•				2.43					•		
: :	7 707	7.4.7								2.57							
: :										2.23					. •		
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+ SPECINEN WAS TOO BECKEN TO TEST. • ASSISTED VALUES OF EFFEIFIC GRAVITY WENG: GRALE = 2.70 (2.40 FOR NEW ALBANY); LINESTONE = 2.71; DOLCHITE = 2.62; SANDSTONE = 2.45.

Table 4.2c (page 1 of 2)

FORT IDICK, EDITUCKY - ROCK TEST REGULTS
MAY 6, 1991

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	: _	Î																						•	
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	PER LA	ĝ	161.1			161.7			139.4			162.0			137.3				145.3		151.2			154.7	
	MODULUS N	Ê	\$			6.13			9.40			9.23			r.				6.57		5.			7	
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Table 4.2c (page 2 of 2)

PORT DIOX, IZHTUCXY - ROCK 1857 8ESALTS MAY 6, 1991 (continued)

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			(3) (3)		;			n.1			3.2	
		E S	8		3.2			9.0			7.	
			(ICF)		163.9			156.0				
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		STEALS AT			5.			3.			6.7	
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* ASSUNDS VALUES OF SPECIFIC GRAVITY WELE: SMALE * 2.79 (2.40 FOR HEW ALLANY)) LIMESTONE * 2.71) DOLONITE * 2.62; SANDSTONE * 2.45. ** HORIZONIAL (CLOSS-ARIS) VALUES / PIRET VALUE IS THE MATHAN FOR THE PLING SECOND VALUE OFFENDIOLIAR TO THE PIRET.

Fable 4.2d (page 1 of 3)

SOUIC VELOCITIES (FT/FEE)	3	DIMETER	12 X		0071 0071 1260 1260			11500			STATE	15700 15100				00171 00171 00171 00171	22 23 28	55 5 <u>3</u>	57 <u>73</u>	88 899 97 991	## ## ## ## ## ##	** *** *** ** *** ***	88 88 88 9: :3 82 2: :3	## ## ## ## ## ## ## ## ## ## ## ## ##	\$2 55 55 55 55 55 55 55 55 55 55 55 55 55	## ## ## ## ## ## ## ## ## ## ## ## ##	## ## ## ## ## ## ## ## ## ## ## ## ##
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			ESS)		161.4			12.3				2.			149.6			31.6	31.6	3:15	.: 4.	6.63 6.63	3. 3.	5. ti	ii	140.9	
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Table 4.2d (page 2 of 3)

FORT DICK, ERFUCKY - ROCK TEST REBULTS
WAY 7 1991
(continued)

MONIC VELOCITIES (FT/FEC)	LATERAL	PINETER	1/1 1/2 3/1	15500 16000 16000 15500 17800 18000				18100 1800 1800 1800 1800 1800	<u>88</u>	600 600 600	888 883 888 888 888 888	888 888 888 888 888 888	888 888 888 888 888 888	00001 00001 00001 00001 00001 00001 00001 00001 00001 00001 00001	0000 0000 0000 0000 0000 0000 0000 0000 0000	800 000 000 800 000 000 800 000 000 800 000	900 900 900 900 900 900 900 900	800 800 800 800 800 800 800 800	800 800 800 800 800 800 800 800	855	855 855 855 855 855 855 855 855 855 855
BONIC VAL	•	AVERAGE		1700				1850	1500	88											
		KIN		15706			18600				. 8			60451 60771							
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		ğ			ğ				g										
		PERM	Î		25	2.5 2.5			30									\$11 as == 52	\$10 as as as as as as as as as as as as as	\$11 as as as as as as as as as as as as as	\$11 as as as as
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		WATER	E (E)	7			2				3	3	3	3 3	: :	3 3	2 2 2		2 2	3 3 3	
		5		153.4			171.3				170.9	. o. i	.	170.9	ë 3	ğ. 4.	178.4	4.84 4.84 7.87	4.84 4.84 7.87	170.1	170.7
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		AKIAL STRAIN AT		6.30			9.42				.47	.47	3	5 5	\$ \$	* **	\$ \$ \$			74. 75. A.S.	73.0
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		Ş			165.4	154.5	5.5	77	1.63	7 8		# # # # # # # # # # # # # # # # # # #									
		M1430	E			5.4.5	57.7	7	37.6		5. E. S. E.	# ## # ## # # # # # # # # # # # # # #	1			E. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.		E E E E E E E E E E E E E E E E E E E	## ## ## ## ## ## ## ## ## ## ## ## ##		
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Table 4.2d (page 5 of 3)

PORT DIOC, KENTUCKY - ROCK 1EST REBULTS

NAY 7, 1991

(continued)

3 E C	AXIAL TUBES WET PALLES (FC)		WITH CACALATED CONTENT POLOGITY	PORCOS ITT SPEC PEDATE (E) (MC)	REABURED T SPEC BAAV	i G	ME .	AIR	AXIA. AVERAME 1/4 1/2 3/4	X X X	MERAL BIWETE 1/4 1/2 3/4	3
6.34 5.74	4 1.55	7.7	•	:	2.5		<u> </u>	84.	9064	<u> </u>	\$8 \$2	22 22 22 23
9.48	167.2	7.2 3.1	2	3	2.62	. 10.0	ğ	1400	14600	22 28 28 28	52 88	22 23 26
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Table 4.2e (page 1 of 3)

REBULTS
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														DONIC VELOCITIES (FT/BEC)	11169	(38/11	
									ž.	MARCHED				•	LATERAL	-	
SWOLE NUMBER	H 44	Ę	STEEDER S	STEATH AT	MODULA MO		MATERIA (X)	CONTENT CALCULATED	POROSITY SPEC (X)	25 25		DE L	WIM.	AVERABE	PIMETER 1/4 1/2 3/4	1/2	1/4 1/2 3/4
-	5.2	1 .	89%		0.27		7	3				STALE					
~	482.0 421.2 ·	301.9	200	2.	9.7	160.0	4.3	•			•	SIMILE	į				
:	421.8	. i	.•						4.	Z. Z.							
= "	3 3		12100	1.1	S.	134.3	1.3	13.9				CARDON	9054	12400	2.5 8.5 8.5	20 20 20 20	222 2002 12200
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R ;	10.	į	•							2.20							
: .		. 52.5	82	9.8	7.3	153.2	2	4.5				SINIE	10900	13900	1300	88 23 23	13200
5	3	262.9								2.2				•	.•		
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	55	****	10100		1.3	140.4	2.0	10.4				CALEGOR		13900	2.5 88	33 33	20 21 20 20 20 20 20 20 20 20 20 20 20 20 20
4	9	28.1								2.42							
		8		•						2.3							
=	14.0	23.3								2.51							
•			178	6.77	3.	152.7	~:	•				STALE .	10300	275	22 23 88	<u> </u>	88 22 23
E	906	214.1								2.32							
•	521.5		28	0.42	5.8	16.3	0.3	0.2				E	004	904	2	<u> </u>	88 22
\$	521.7	7.18							6.1	2.74	98						
K	22.	200.0	9004	3.	2.50	171.9	1.5					1881				-	
=	532.0	E							5.7	2.8	132.8 295.88						
•	200	1.00	4000	.30	3.07	153.6	5.1	17.0				절	812	1400	<u> </u>	<u> </u>	15200
ä	¥ 5.	19.5		•					5.9	2.	2.57						

Table 4.2e (page 2 of 3)
rost mox, tentuary - nox test seests
(continued)

1														SORIC VELOCITIES (FT/FEC)	CITIES	IT/RC	
									2	HEAGURED					LATERAL	=	
		. 2	5	2	TOLMO'S	5	1	CALGALATED	PORCETT	Ę	retor.	POS				PERMET	E
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	2.6.8	18.3							••	2.84	25						
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	i ë	132.4							7.	7.	28						
	\$6.6	163.1	•						11.4	2.63	22				•		
	83	3.5	13100	e.3	4.67	18.6	2.5	5.7			-	ğ	1500	18600	18500	25	25 25 26 26
		14.							3.2	2.83	=3						
•	9.5	22.5	924	r.	6.91	163.0	4.0	10.5				Ę	17200	90191	17400	255 250 250 250 250 250 250 250 250 250	27. 2017
	1 5	#			-				4.0	2.	1515.80						
	9	. 22.5	9100	8.	2.	162.7	2.0	2				호					
	3	11.5							;	2.65	 5.5	•		•			
	7.0	2.0	8	0.39	8.	168.7	2.	5.				호	16900	17800	250 200 200 200	17108	25.00 00.00
	i i	8.7							:	2.2	13.77						
	5 67	5							2.7	2.7						-	
	54.5	6.5					-	٠.	4.4	2.8	38						
		25	18900	7.	4.74	171.4	2	3.6	-			ğ	20102	1800	9024	\$2 \$2 \$2	814
	3		58	0.67	7. 2.	169.9	=	5.				ğ					
_	£ 53								7.2	2.63	52	•					

Table 4.2e (page 3 of 3)

rear men, menuex. noex rest assuts
MN 7, 1991
(continued)

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		8				2		2		2.03	2.7			2.74			
		HEARING .	T SPEC	3		2.85	•			N.	ä		-	~i			
		-	PORDRITT SPEC	8		5.4		P.		•				••			
			CALCALATED	CONTENT PORCELLY*	5.3				2			0.2	2.5		. 2	•	
١			MATER	E CE	3				ä.			0.2	6.3		7		
					14.8				163.9			160.0	165.4		10.3	16.0	
			Totale's	Z.	4.17				2.8			3.5	1.6		1.4	1.55	•
			AIM	38	2.0			•	19.0			17.0	6.7		4.	\$	
					14300		•			•			97			8	
					5.23												
					5	3 3	<u>:</u>	4.0.4			27.69			. e.	8	7.87	20.5
					=							Ę		92	=	=	

* ASSINED VALUES OF SPECIFIC GRAVITY MEDE: SHALE * 2.70 (2.40 FOR MED ALAMY)) LINESTONE * 2.71) DOLONITE * 2.82) SANDSTONE * 2.45. ** MORIZONIAL (CROSS-AXIS) VALUES FIRST VALUE IS THE MAXIMAN FOR THE PLUCY SECOND VALUE ONTAINED PERFERDICALAR TO THE FIRST.

Table 4.2f (page 1 of 6)

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11/MEC)	_	DIAMETER	14 12 21	25 88	158 158	\$2 88	\$ <u>8</u>	88 85	28 28 28	\$5 88	88 88	£23	<u>20</u>			200 200 200 200 200 200 200 200 200 200	88 65 -		88				
11120	LATELA		\$		22 24	<u>8</u> 3	3 §	100	8	Ē	2 <u>2</u>		22.25 20.25 20.25			<u>27</u> 88	25 38		32 88				
SORIC VELOCITIES (FT/SEC)	LATELA	AVERAGE		8	8044	1000	10400	11200	10900	118	12000	12300	12700	•		13100	13900		12100				
2		AXIAI	- 1	870	0004	8	9	200	9004	Ē	80	8	00201			921	900		1730				
	:	NO.	1	BINTE	BINNIE	FIRALE	BRALE	BHALE	BIVIE	BINTE	STALE	SHALE	SHALE	SE SE	CURRON	# TE			턽				
		FERM	ĝ															₹ 9.01		10.0 >	₹ 0.01	10.0 >	4 0.01
	23	:																7.2		2.62	2.72	2.62	2.8
	MEASORED	70808177	3													****		2.7		9.	•.	•	;
		WITH CALCULATED	8	10.9		••	2	:	=	7	11.5	13.3	1.1	7.6	3	2.0	11.3		y.,				
		MITTER	8	3	;	;		7.7	7.	5	5 .0	7	2	0.0	2.3	\$:	3		2.7				
			(30)	157.5	139.1	140.0	161.5	4.4	1.101	6.2	134.8	142.5	147.0	142.7	155.6	163.6	143.5		13.6				
		HODA		i	:	i	į	:	:	9.18	1.1	3.	3.	1.8	10.55	2.0	F. 3						
		STEALS AT	(A)	2.00 +	3.	3.	3.	3.	1.27	1.48	9 .	1.21	0.55	6.73	9.30	9.76	4.0		72.0				
		3	(184)	1000 +	9072	270	270	2000	2002	1600	7300	11500	8059	2300	3000	9025	7400		1200				
		EL?	(TT)	416.2	33.5	13.5	35.4	 88	315.6		-	25.50 25.0		25.5	23.4	25.5	<u> </u>	1.541	12.7	1.61	100.2		162.2
		BEPTH	(<u>T</u>	2.5			. 7.101	- 7:E	141.3		55	200	22.2	240.6	. S.	33	202.2	25.25	247.0	7.892	zm.s	7.72	
		-	=-																				

Table 4.2f (page 2 of 6)

PORT KNOK, KENTUCKY - ROCK TEST REBULTS
(NOT 7, 1991)
(continued)

SONIC VELOCITIES (FT/RES)	LATERAL		1/2 3/4		14200 17100 17100 17100							90411 90871 90471 90871	11500 10700			1000 1600 1000						• ·	•	•	•	• •	•	•
WLOCITIES	3				8 27 26 26 26 26							90 101 101 101 101 101 101 101 101 101 1	000			3												
SONIC			MINE AVENUE		16300 16500							19500 14500	2600 13600		•	19000 13706	•					•	•	·	•	•	•	·
		X			DOL -163							193	20.			2 0			ಕ್ಷ	8	ಕ್ಕ	8 .5	ಕ್ಕತ	8 .5	ಕ್ಕ	ಕ್ಷ	ಕ್ಷ	ಕ್ಷ
			-		۵		2	_	_		-	•	•			6	_		•									
		ž	65	5.		4 6.01	¢ 0.01	₹ 0.01	÷.	1.17	4			4.4	7.2		2.3				32.0	32.00 12.00	32.8 6.43 6.6	8.27 8.49 8.0	8.22 8.43 8.0 8.0	8 8 8 8 5	8.22 8.22 8.9 8.0 8.0 8.0	22.00 24.00 24.00 27.41 20.00
	MEASURED	24.		F.3		2.8	2.8	2.2	2.63	2.1	2.5			2.2	2		2.2				2	1 1 E	ä 5 5	# # # # #		* * * * * * * *	3 5 5 3 3 3 5	
	-	PORDRITY BPEC	8	3		9.6	5.3	3.0	;	:	7.2			7.5	•••		3				12.3	2. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	12.3 14.2 15.5	15.3 17.3 17.4	2		3323333	222422
		CALCALATE	CONTIDER PORCELLITE		;							1.1	:			10.2		10.4		10.1	5.		10.1	 	1.0	•	÷	•
					7.							7	:			3.7		3.2		2.5	2	2	2	3	2	3	3	3
				1	168.0							170.0	169.3			163.6		142.8		163.6	163.6	3						
			¥£		3.6							4.01	3.			1.15		5.9		6.76	5.7	6.76	27.9	5.	2	?	?	?
		AKIAL STEAJE AI	CEST PAIURE		9.4							7.	9.76			9.24				:	:	=	=	=	•	•	•	•
		9			1660	•			•			7400	288			8		84		200	£	974	8	8	8	8	8	8
		2	8	i.	EE	17.	176.4	17.1	16.0	146.0	1.4	17.7	3	1 1	9.0	35	1.961	53.5		. 55.2 55.2			****					
		made		1 "	ĒĒ	2.6	22.5	¥.	27.7			E	_		É	ž.	27.2	1		i.	EE E		F. E. S. S.			200 M M M M M M M M M M M M M M M M M M	######################################	######################################
			2	:	=	=	3		=		2	=	3	:	2	2	2	R		×	× 5	* 5 5	x 888	* * * * * *	* * * * * * *	* ****	* 525255	* *******

Table 4.2f (page 3 of 6)

PORT IDION, ICHTUCKY - BOCK TEST RESULTS
(NAT 7, 1991
(continued)

														SCHIC VELOCITIES (FT/TEC)	CITIES (11/EEC)	
									¥	HEASURED				LATERAL	LATERAL		
EAMOLE	11.00	FLEV	3	CTEAIN AT	TOLNIG'S		WIER	CALCULATED	POROSITY SPEC PERM	£	Ē	M					
7. T. T.	E		STRENGTH PAILURE (PSI) (X)	A CO	7 C. E. C. E. C. E. C. E. C. E. C. E. C. E. C. E. C. E. E. C. E. E. E. E. E. E. E. E. E. E. E. E. E.	(PCF)	(X)	CX) (X)	€	SEAV.	Î	1 41:	AXIAL	AVERAGE	ž	1/4 1/2 3/4	ž
2	316.5	1.0.1			•				16.8	2.77	152.00						
	310.7	130.2							4.2	2.84	9.0		:				
1	321.4	133.5	•						10.3	2.2	0.62						
=		135.4	9044	6.33	3.8	163.3	7.7	10.0			,	ಕ್ಷ	1230	12800		13000	1226 5226
22	322.0	134.9							10.4	2.63	O.62						
ñ	17. VA	12.3	•						7.7	7.5	6.11						
572	326.0	130.9								7.5	c.2				٠	•	
ñ	329.6	117.3							3.7	 8	a. 26.						
72	27.02	12.7							5.9	7.	A 0.01		•				
Ë	978	123.3							3.7	2.6	A U.M						
	200.0	120.3					٠		2.0	2.63							
3	340.6	116.3							2.2	2.2	* 0.9				•		
=	7.01	116.2							2.5	 a	5.	. ((ten.				
=	342.2 342.2	115.2	20700	0.X	Z	172.3	•:	5.2) E	2000	979		977	8 8 2 2 2 2
31	X2.2 X2.5	- 17.7	\$	•. 1	10.44	173.2	•	~				<u> </u>		•			
=	¥2.5	114.4	13600	37.	6. 0	17.5	••	3 .) 2 2 3					
£	343.3	113.6							2.6	2.2	6.62						
800	7.42	112.2							2.0	2.5	¥ •.9						
318	347.2	109.7							;	2.2	B.					-	
ī	351.6	13.3							7.7	2.63	1.47						•
5	351.6	15.1	929	0.0	3.6	ž.	3.7	:				ğ	<u> </u>	1 50	25 25 25	\$ 5 8 8	8
2	352.3	104.6	2500	0.17	4.54	159.7	;	13.3		1		호					
328	352.9	10.0							12.9	7.8	167.00						

Table 4.2f (page 4 of 6)

PORT DICK, ERTUCKY - ROCK TEST RESATE
MAY 7, 1991
(continued)

														SOUTE VELOCITIES (FT/SEC)	SILLES	(FT/MC)	
									¥	HEARLIED				LATELAL	LATERAL	_	
9 10113		2	9	STAIR AT		5	MITTER	CALCULATED	PORCHITY SPEC	Ĕ	E	ğ				DIMETER	
SK-SE	€	E	(18°)	CPSI) (X)	Z.			CEO CEO	8	à	Ê	E		AVEZVE	ځ	1/4 1/2	×
×	<u>:</u>	103.0	623	97.0	3.	163.5	3.6	10.3				20					
	255.5	3 3							5.5	8.8	0.02		•				
ā	22.7	7.6							7	2	4 0.01						
=	-	- -						į	;						544		3
=	33	żż	1000	77.0	5.37	£.5	:	÷.				턽	8	8	8020	200	3
75	342.8	7							5.0	2.63	× 0.01						
33	7.3	72.2	•						9.0	2. 2.	. 0.01						
3	364.6	2.2							17.9	2.8	4.2				•		
2	7.5		22	\$	9.30	146.8	2.0	3.6				BRALE	10900	13600	1530	25 85 85	23 88
3		2							3.3	2.63	6.9						
Ē	1								7.7	2.8	6.21						
. 5	3	2							6.	¥.¥	6.0						
=	7.85.7	4.2			-				;	2. E	9.6						
3	75.0	63.0							22	2.63	.						
=	34.9	62.0							:	2.63	8.			•			
=	33.6	2.2 5.3	15000	0.32	6.41	E.	2.5	•				Z	200	<u>8</u>	55 50 50 50	25.08	2860 00 00 00 00 00 00 00 00 00 00 00 00 0
5	33.5	4.10							2	7.2	9.8						
3	38.2	7.2						٠	:	2	6.62						
127	1.007	8.8							7.7	2.0	8.						
22	44 	27.2	10800	27.0	3.	FE. 5	3.6	;	. (ಕ	148	24	4500	88 2=	88
32	1.101	32.2							11.3	2.64							
3	465.9	51.0			•				: ;	75.8	6.0					•	
Ę	109.2	47.7							6.0	2.84	0.33						
2	410.4	44.5							•••	2. B	E						
a	410.9	33	13100	0.21	7.55	167.6	2.	7.2				젍	<u>1</u> 8	16600	55 55 55	200 200 200	88

Table 4.2f (page 5 of 6)

								(Carried)									
													_	SONIC VELOCITIES (FT/FEC)	CITIES	(11/880)	
									I	HEASURED					LATERAL	7	
1	MT-230	FLTV.	3	STEALS AT	BOOK IN	3	WIER		POROSITY BPEC	Ë	ž	100 100 100 100 100 100 100 100 100 100		DIMETER		DIAMETER	_
SE.	CLLO	(T)	(184)	3	32	(104)	3	(x) (x)	8		ĵ	1	MIN		š	1/4 1/2 3/4	×
\$	412.6	4.3							-	2.2	1.72						
ŝ	417.7	39.2							7.3	2.8	€ 0.01		•				
8	4.9.9	37.0	٠						•.•	¥.	0.01						
3	122.0	X.*							5.1	×.	0.02						
ឆ	1.8.7	31.2							7.4	2.8	• .04						
ឯ	122.22	1.00	8	9.36	3.12	167.9	2.9	7.2				STALET POL	15200	13000	1090	22 88	15000
536	1777	30.5							7.7	2.63	0.02						
*	430.4	22.0 2.4.0	28	6.33	Ž.	1.431	3.0	9.0				ğ	14300	. 15400		527 807 807	
×	431.5	3.4							1.1	2.2	₹ 0.01						
22	431.4	3 .1							6.2	2.7	0.10						
378	434.2	7.22							0.0	2.2	₹ 0.01						
53	440.5	1.4							7.3	2.0	€ 0.01	,					
3	443.0	13.0							1:1	2.73	0.62						
Ë	1.911	10.2							3.6	2.	9 .8						
š	447.8	:							1.0	2.74	9.01			•			
ສ	##	7.7	10000	Ŋ.	6. 3	167.2	0.3	-				BIALET UST	19600	13600	<u>35</u>	<u>\$15</u>	25 26 26 26 26 26 26 26 26 26 26 26 26 26
n	448.8	-							••	2.7	₹ 0.01						
9	452.2	4.7							1.5	2.74	4 0.01						
ŧ	454.5	7.7							5.6	2.7	0.8						
2	456.7	0.2							4.6	2.12	. 9. 01					-	
2	458.7 •	• • • •	220	7.	3.1	168.9	1.2					בבל פומום	1618	13200	14100	35 35	16.00
2	459.2	-2.3							•••	£.3	4 0.01						
53	1.457	-2.5							2.7	2.7	• • •						
3	4.134	-4.7							3.4	2. 3	4 0.01						

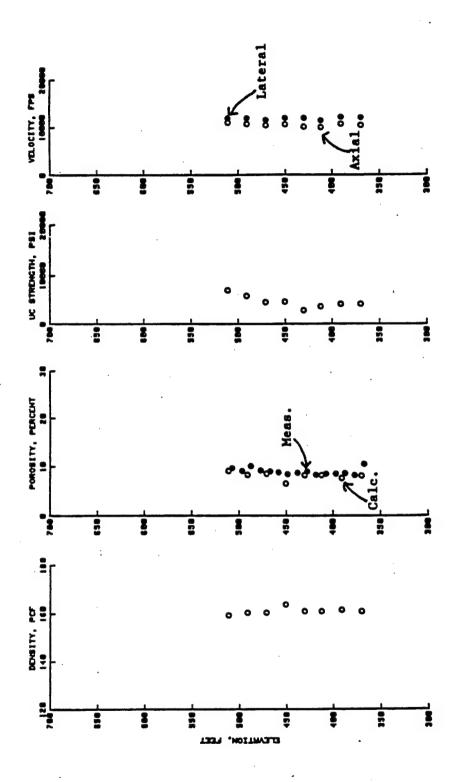
Table 4.2f (page 6 of 6)

FORT EXCH. EMPLOY - BOCK 1887 MEALTS
WAY 7 1991
(continued)

														ICHIC VELOCITIES (FT/TRES)	1116	(7M/MC)	
									3								
				WIM	POLING'S				MANAGER	NEAD OF THE PERSON NAMED O			·	**************************************			:
	200		STREMETT	TA PATURE	ernos x		CONTER	WIER CALCALATED	POROS I TY	24 8 8 8	Į.	ğ.	AXIAL	AVERAGE			
(1K-1)	ŝ		Ê	8	Ē	ĝ	8	£	8		9				٤	2	≴
659	445.0	-9.1							3.4	2.7	8.0						
22	33		000	3.	7.7	167.6	2.5	673				SIMILE	15400	13500	1108	<u> </u>	22 20 20 20 20 20
*	£.5	11.6							5.7	8.2	* 0.01						
3	473.2	-16.3					•		3.3	2.3	4 0.01						
Ę	1.74.1	-19.2	•						2.8	2.7	8.0						
3	177.0	·a.1	•			٠			2.3	2.73	4 0.01						
2	1.041	·8.5							3.5	2.7	3.						
2	33	5.5.	11700	0.X	4.57	14.2	•:	••				U857/ 814/4	907T	12800	2.8 88 88	3 <u>11</u> 32	82 88
5	4.2.4	.8.5							3.6	2.3	¢ 0.01				• .		
8	445.0	-1.12							1.	2.7	4 0.01				••		•
2	***	-31.5							;	27.22	4 0.01						
2	1.047	·13.4							3.4	2.7	A 0.01						
Ē	473.0	-34.1							2.0	2.7	* 0.0						
7.	42.5	-39.6							:	2.7	¥ 0:01						
ž	1.67	41.3							1.1	1.7	4 0.01						•
3	479.5	-12.6							3.3	2.7	۸ 0.01						
2	53.7	-12.5	900	6.32	N.09	7.85.7	7.7	. 5:1			•	<u> </u>	16200	13606	925 925 925	13400	
2	500.2	-13.3							።	2.73	÷.						
E	502.0	-45.1							3.0	2.7	.0.0						
ž	504.5	-47.6							2	2.74	4 0.01					-	
	Cat 0.000 10.000	AND TAXABLE TA BA	2411141														

+ SPECIMEN MAR NOT TAKEN TO FAILURE. • SPECIMEN IND PATEET MOLIZORIAL FLACTURE. •• ALENAED VALUES OF EPECIFIC GRAVITY WERE: SHALE = 2.70 (2.40 FOR NEW ALENAY); LINESTONE = 2.71; DOLONITE = 2.62; SANDSTONE = 2.45.

Figure 4.1 Summary of Laboratory Test Results for Rock Cores from Boring CB-1, Ft. Knox, KY



Summary of Laboratory Test Results for Rock Cores from Boring CB-3, Ft. Knox, KY

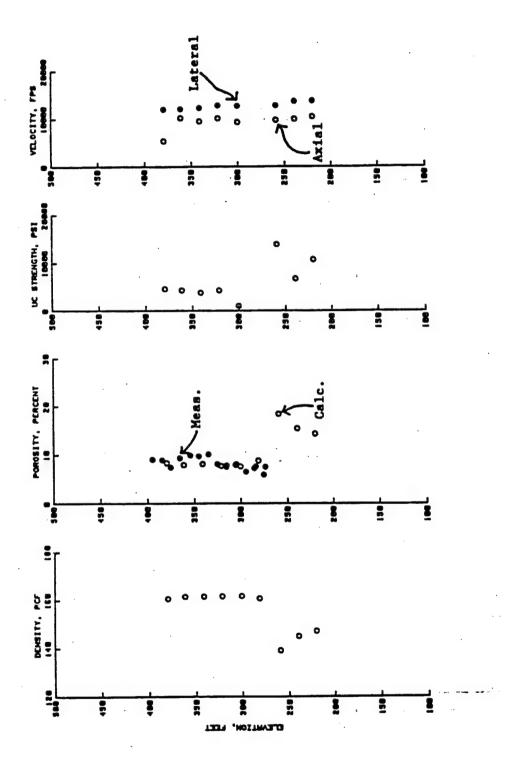


Figure 4.3 Summary of Laboratory Test Results for Rock Cores from Boring CB-4, Ft. Knox, KY

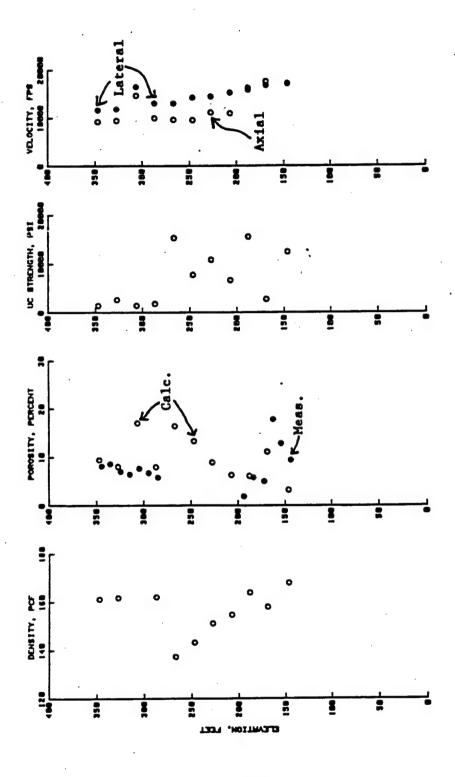


Figure 4.4 Summary of Laboratory Test Results for Rock Cores from Boring CB-5, Ft. Knox, KY

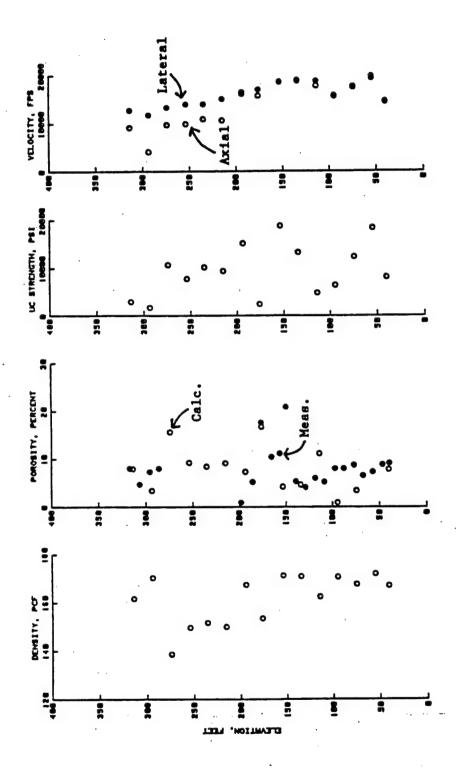


Figure 4.5 Summary of Laboratory Test Results for Rock Cores from Boring CB-6, Ft. Knox, KY

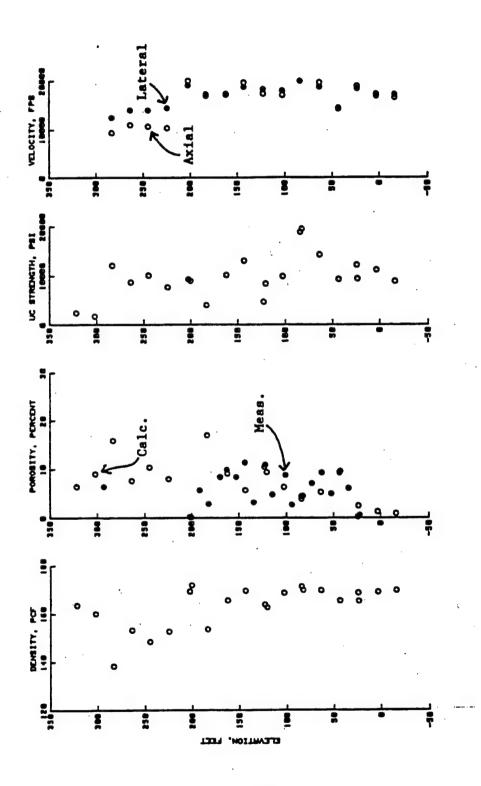


Figure 4.6 Summary of Laboratory Test Results for Rock Cores from Boring FK-1, Ft. Knox, KY

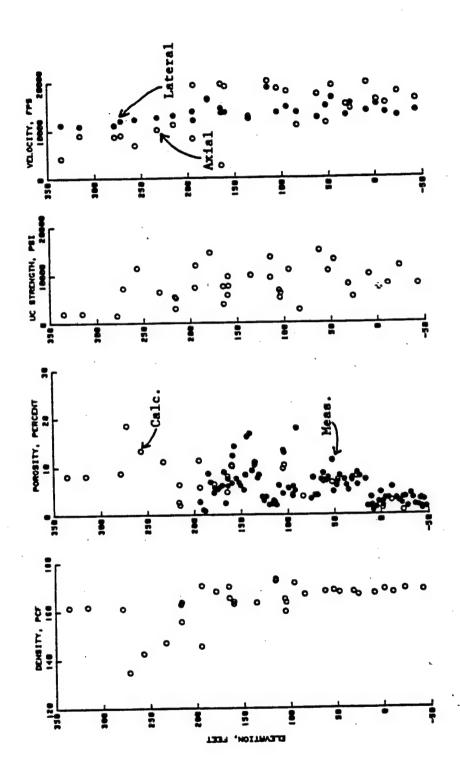


Table 4.3

SUMMARY OF RESULTS OF TENSILE TESTS ON SHALE CORES
FROM UTP BORINGS CB-1, CB-3, AND CB-4 (UPDATED 6/17/91)

Boring No.	Depth (feet)	Dia. (in.)	Ht (in.)	Loed (lbs)	Weight (grams)	Wet Density (pcf)	Water Content (%)	Dry Density (pcf)	Indirect Tensile Strength (psl)	Direct Tensile Strength (pal)
CB-1	175.65	1.762	0.964	1506	97.42	157.9	4.23	151.5	564.4	_
LD-1	190.80	1.763	0.961	1007	96.91	157.4	4.15	1217	378.4	-
	206.00	1.760	1.028	980	104.53	159.2	4.23	152.8	344.8	-
	220.35	1.759	0.967	908	96.97	157.2	4.05	151.1	339.8	- •
	265.45	1.760	0.959	608	96.71	157.9	4.54	151.1	229.3	
	279.85	1.762	1.000	599	102.05	159.4	4.67	1523	216.4	-
	279.95	1.757	0.982	808	100.19	160.3	424	153.8	298.1	-
	285. 5 0	1.757	0.933	880	95.63	161.0	3.59	155.5	341.8	-
	291.55	1.756	0.989	735	100.68	160.1	3.75	154.3	269.4	-
	294.10	1.761	0.938	ങ	95.43	159.1	3.85	153.2	251.7	-
	295.25	1.751	0.942	762	95.41	160.2	4.11	153.9	294.1	-
	299.65	1.757	0.977	626	99.22	159.6	4.12	153.3	232.2 182.8	_
	304.70	1.759	0.978	494	103.39	165.7	3.68	159.8	269.5	-
	309.50	1.763	0.887	662	89.99	158.3	4.39	151.7	256.2	_
	309.60	1.759	1.000	708	101.58	159.2	3.78	153.4	202	_
CB-3	330.40	1.748	0.941	1134	94.22	158.9	4.22	152.5	438.9	-
	345.05	1.762	1.005	1171	102.31	159.0	, 4.30	152.5	421.0	-
	360.00	1.763	0.969	1180	97.66	157.3	4.62	150.3	439.7	-
	374.85	1.759	0.992	1370	100.73	159.2	4.48	1524	499.8	-
	390.10	1.759	1.002	1624	102.58	160.5	4.34	153.8	586.6 274.4	_
	405.05	1.762	0.956	726	96.39	157.5	4.38 4.28	150.9 154.2	230.2	_
	411.50	1.728	0.901	563 1071	89.19 101.14	160.8 160.5	4.32	153.9	392.2	_
	414.80 420.25	1.758 1.761	0.989 1.062	1271	109.65	161_5	3.91	155.4	432.7	_
	425.50	1.761	0.953	1162	97.83	160.6	4.58	153.5	440.8	_
•	430.40	1.759	1.035	1198	106.18	160.8	4.42	154.0	418.9	-
	435.50	1.760	1.070	1316	108.72	159.1	4.30	152.5	444.9	_
	440.60	1.762	0.979	2949	82.56	131.8	1.99	129.2	1088.3	-
	445.10	1.763	1.005	2931	93.67	145.5	1.30	143.6	1053.1	-
	450.70	1.765	1.056	3866	95.18	140.3	1.10	138.8	1320.5	-
	465.05	1.763	1.003	2078	97.63	151.9	2.01	148.9	748.1	-
	479.40	1.762	0.961	2514	88.37	143.7	2.12	140.7	945.2	-
CB-4	366.60	1.865	1.000	944	114.27	159.4	4.26	152.8	322.2	_
	380.15	1.864	0.998	1125	114.29	159.9	3.99	153.7	385.0	-
	395.20	1.768	1.005	896	110.07	170.0	3.36	164.4	321.7	-
	409.45	1.762	0.972	1343	99.19	159.4	4.41	152.7	499.2	-
	424.10	1.767	0.994	1143	102.72	160.5	4.61	153.5	414.3	-
	435.00	1.776	4.346	24	453.53	160.5		155.7	-	1.0
	439.90	1.773	0.993	3394	89.42	138.9	1.40	137.0	1227.3	_
	443.52	1.773	4.305	279.4	373.31	133.8	1.00	132.5	-	1132
	456.25	1.772	4.232	153.7	393.13	143.5	1.16	141.9	-	623
	456.70	1.771	0.957	1815	91.86	148.4	1.75	145.9	681.8	_
	461.70	1.770	1.010	2042	96.83	148.4	1.47	146.3 145.2	727.2 727.9	_
	466.10	1.774	0.989	2006	94.45	147.2	1.40 2.21	148.6	886.7	_
	470.50	1.773	1.014	2504 257.2	99.78 401.06	151.8 147.7	1.87	144.9		104.6
	475.30	1.769	4.210 1.022	2441	97.01	147.0	1.84	144.3	859.1	_
	475.60	1.770	0.987	2405	101.21	160.9	2.61	156.8	882.4	_
	480.60 486.00	1.758 1.770	0.940	1815	89.03	146.6	1.83	144.0	694.5	-
	486.30	1.769	4.139	235.6	396.44	148.5	1.85	145.8	-	95.9
	491.10	1.770	0.968	2296	97.02	155.2	2.45	151.5	853.1	-
	495.85	1.767	4.235	261.7	440.13	161.5	2.70	157.2	-	106.7
	500.00	1.771	1.016	2568	P622		2.23	143.3	908.6	-

Figure 4.7
Tenisle Strength Tests, Boring CB-1
BORING: CB-1

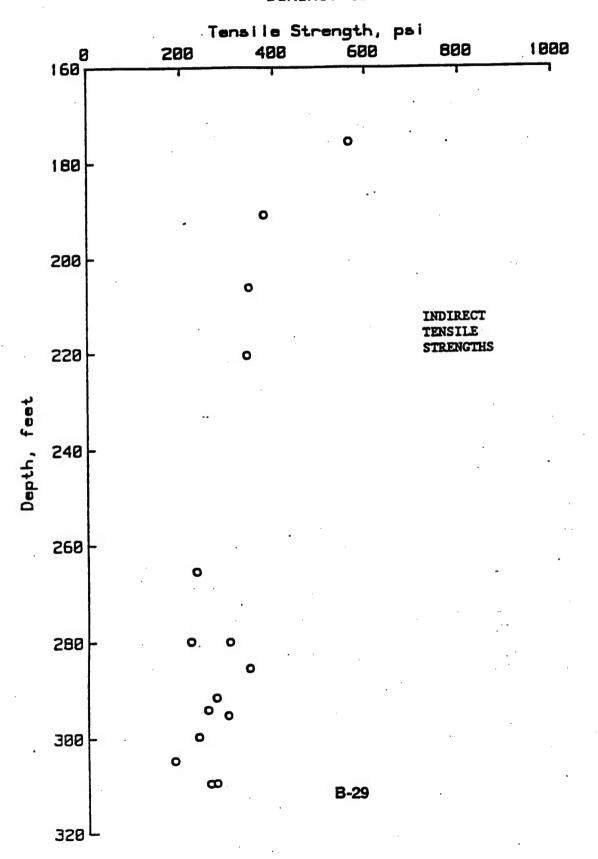
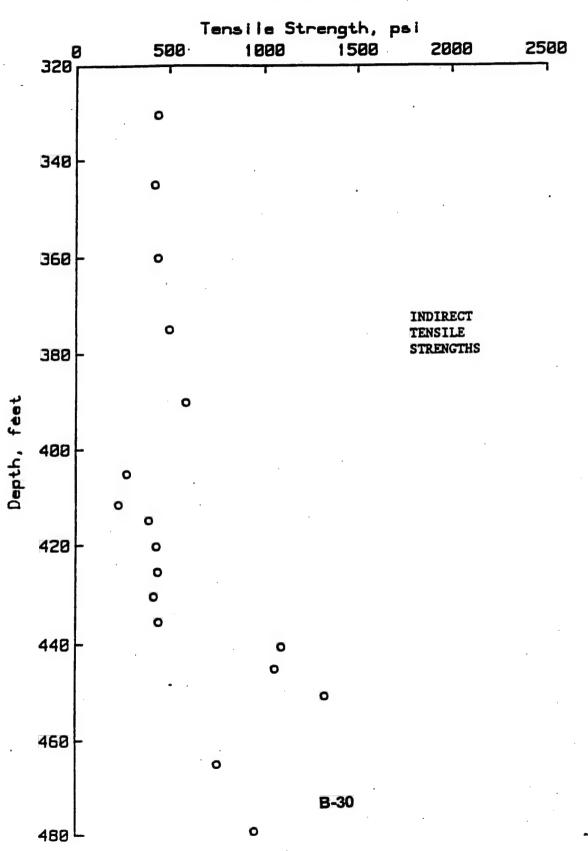


Figure 4.8
Tensile Strength Tests, Boring CB-3
BORING: CB-3



BORING: CB-4

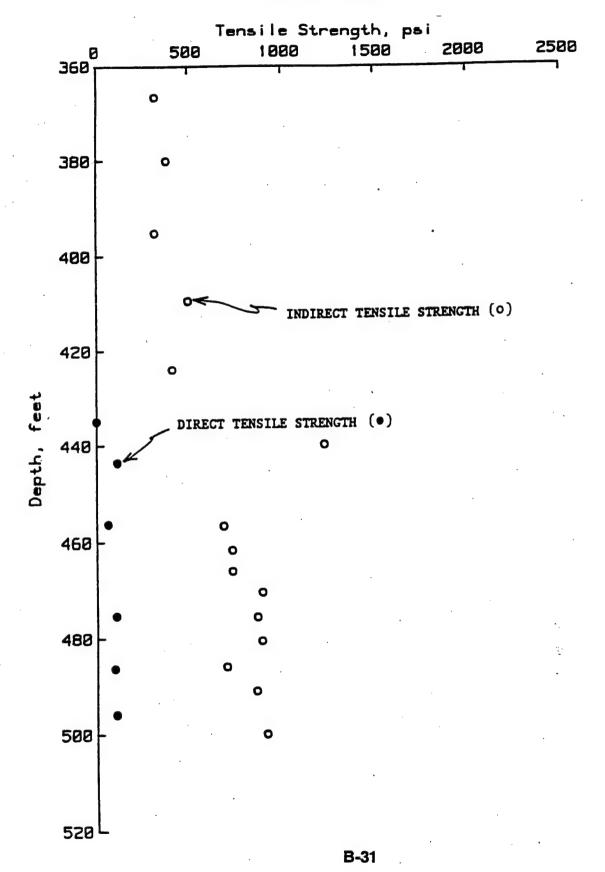


Figure 4.10 Composite Plot of Strength Test Data for CB-1, CB-2, and CB-4

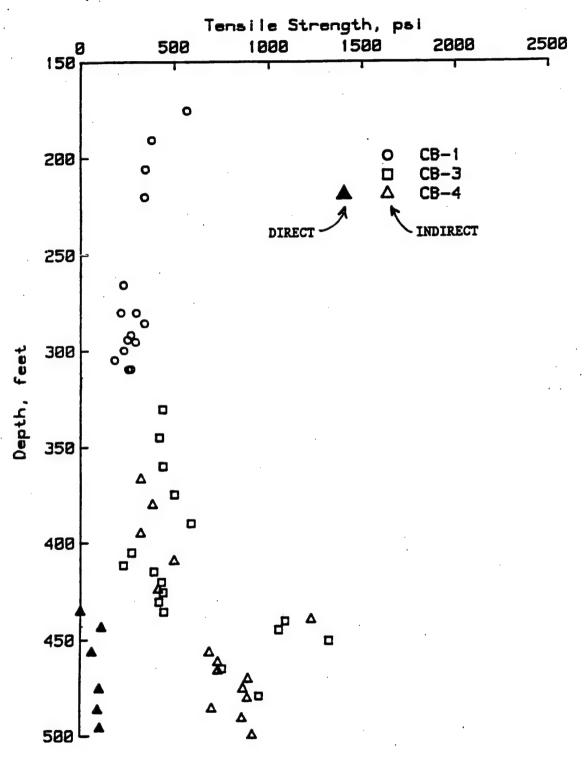


TABLE 4.4

QUANTITATIVE X-RAY DIFFRACTION ANALYSIS

Hole #	Depth (ft)	Formation	Clay-%	Qrtz-%	Fldspr-%	Calc-%	Dolo-%	Other-%+
CB-6	429.9	N. Prov.	5	23	3	<1	5	68
CB-6	453.2	N. Albany	12	19	7	<1	<1	72
CB-6	536.0	Louisville	1	1	•	-	98	1
CB-4	426.0	N. Prov.	12	23	7	<1	<1	68
CB-4	460.2	N. Albany	9	28	7	<1	1	62
CB-4	521.8	Jfsnvl	1	1		78	20	1
CB-4	555.5	Louisville	1	2		<1	97	1

⁺ Other represents all "other" material not detected by X-ray diffraction analysis, e.g. organics and amorphous material such as glass

Appendix C Geologic Maps

	,
Job No.	No
	 IWO

Project UTP - Ft. Knox, KY	Computed G. Alsayab	Date
Subject Geological Mapping of Tunnel	Checked	Date
Task	Sheet 1	or 72

- * Geological Mapping was done according to the "Full Periphery Method" which is explained in the Engineer Technical Letter No. 1110 1 37, published by Dept. of the Army Office of the Chief of Engineers Washington, D.C. 2031 and Lated 18 Sept. 1970
- * In this specific mapping of the UTP tunnel, the assumption that Magnetic Declination @ Ft. Knox, KY is Zero, was utilized and extendation of geologic discontinuities of Lilling planel. encountered was measured in Magnetic Azimuth using a Brunton Compass.
- * Main Tunnel orientation, prior to curve = 335° Az
- * Contractor did not maintain station marking along tunnel during excavation. Stations were marked every 100' lover shotcrete liner later on.
- * Whole tunnel is lined with shotcrete of 2' thickness minimum.

Scale: 1"= 6" horizontal
1"= 5" Along Tunnel Axis

Legend:

? : Estimated

cave in cast (fell-out)

: Siderite Nodule or cast

O or □: Rock dowel

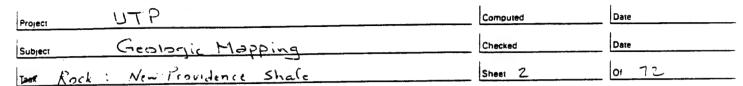
□ : Tensioned Pock Both

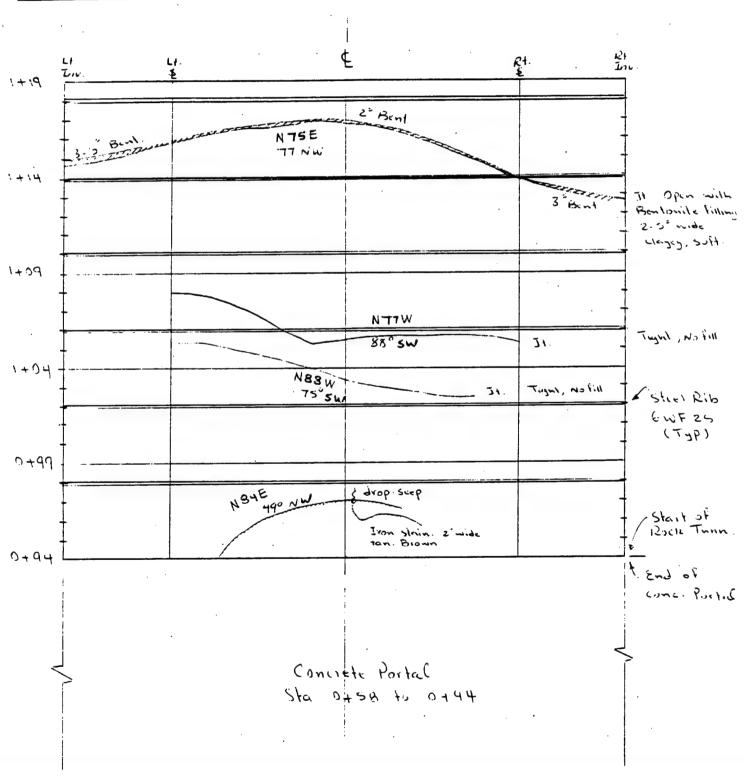
8 : Scepage

+++++ : Staining

Filling Material

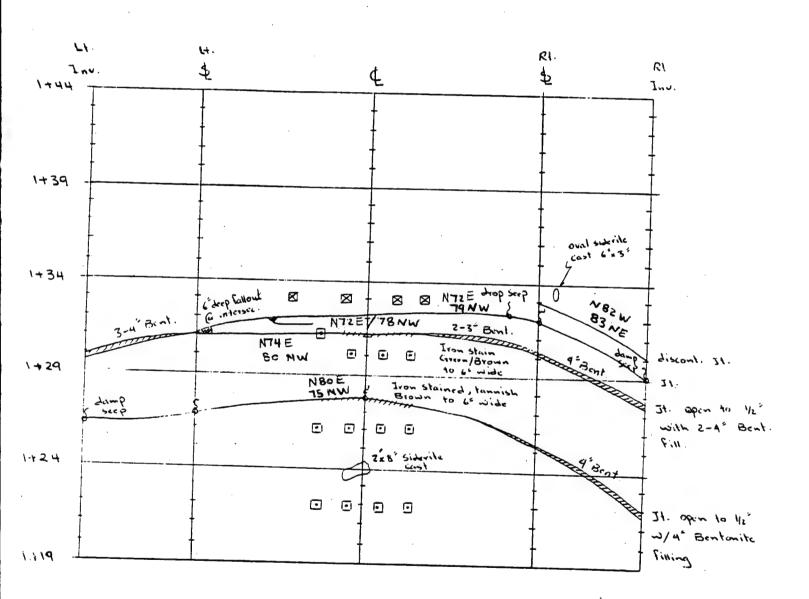
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סאו ססג	 140





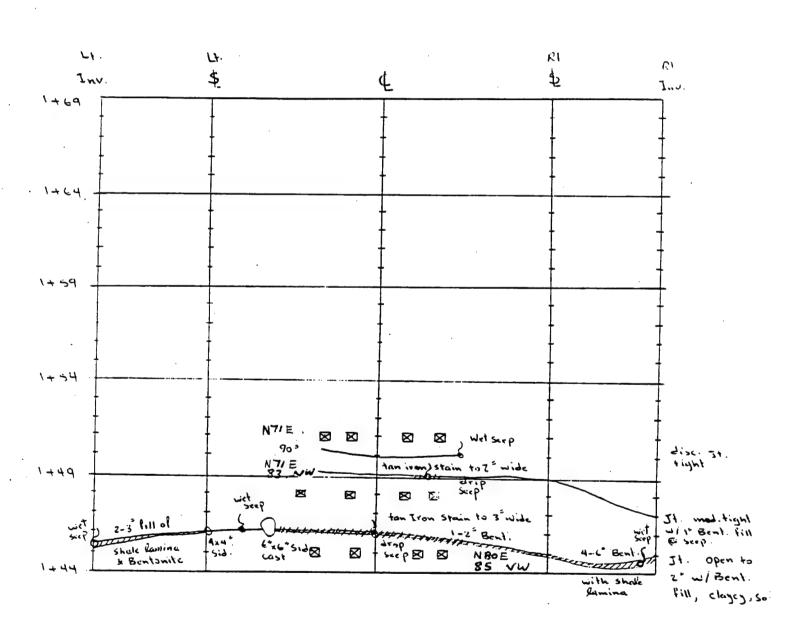
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	Job No.	No

Project UTP	Computed	Date
Subject Geologic Mapping	Checked	Date
Took Rock: N.P. Shale	Sheet 3	01 72

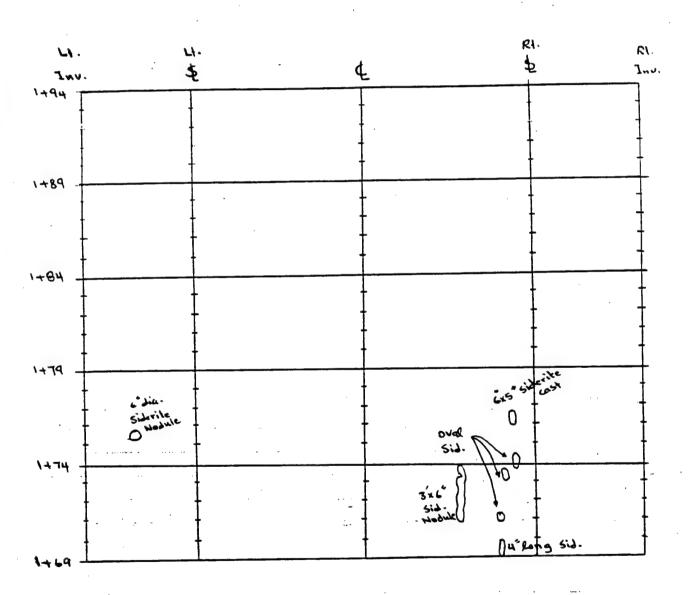


Job No.	No
300 110	140

Project	UTP		Computed	Date
Subject	Geologic Mapping		Checked	Date
Task	Rock: New Providence	Shale	Sheet 4	01 72

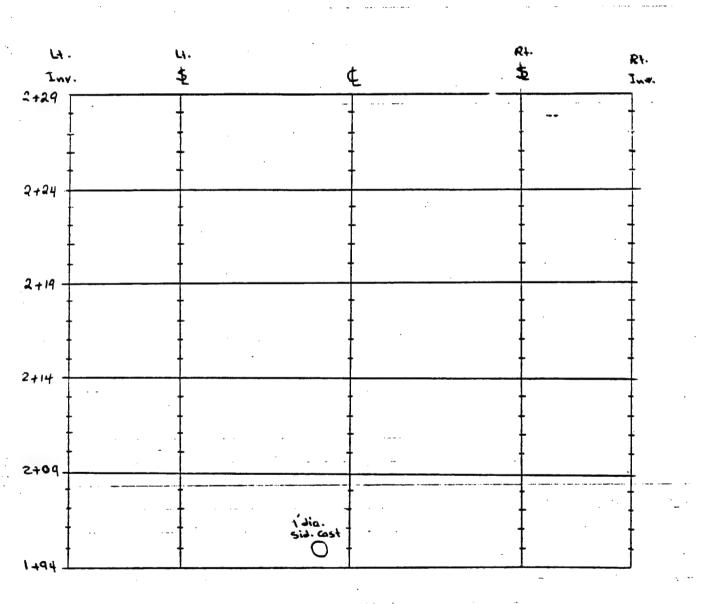


Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Teek	Rock: N.P. Shale	Sheet 5	ot 72



Massive Rock No Joints

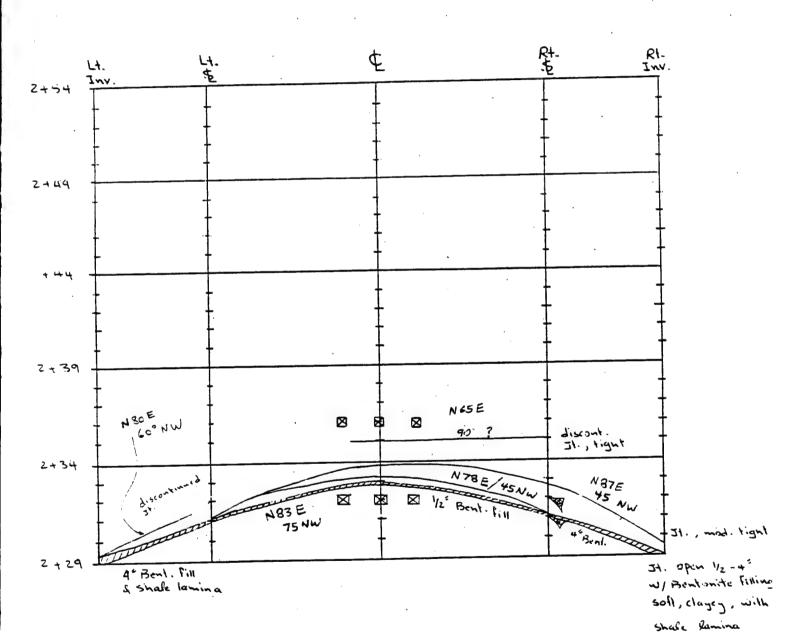
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Subject	Geologic Mapping	Checked	Date
Took	Rock: New Providence Shale	Sheet 6	01 72



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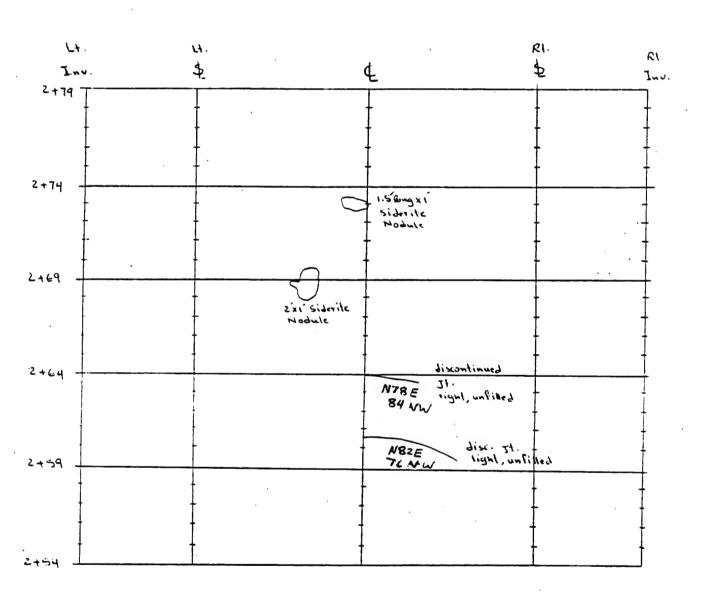
Job No.	No
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Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet 7	01 72

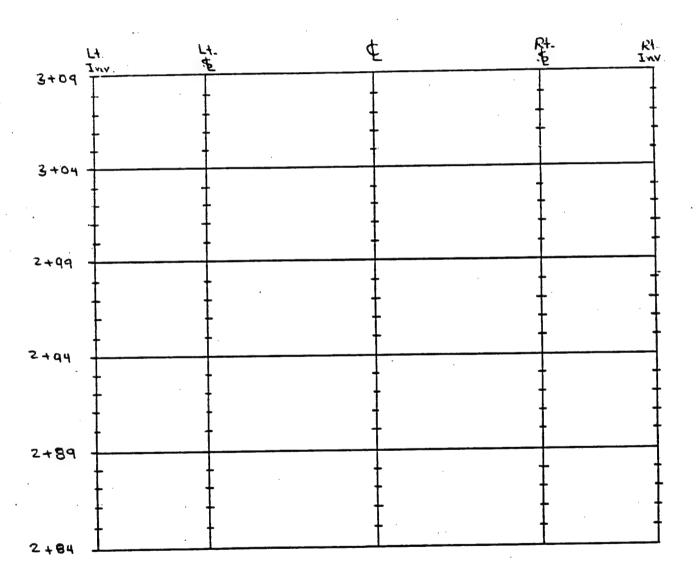


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Subject			Checked	Date
Taurk	Rock: N.P.	shale	Sheet 8	of 72

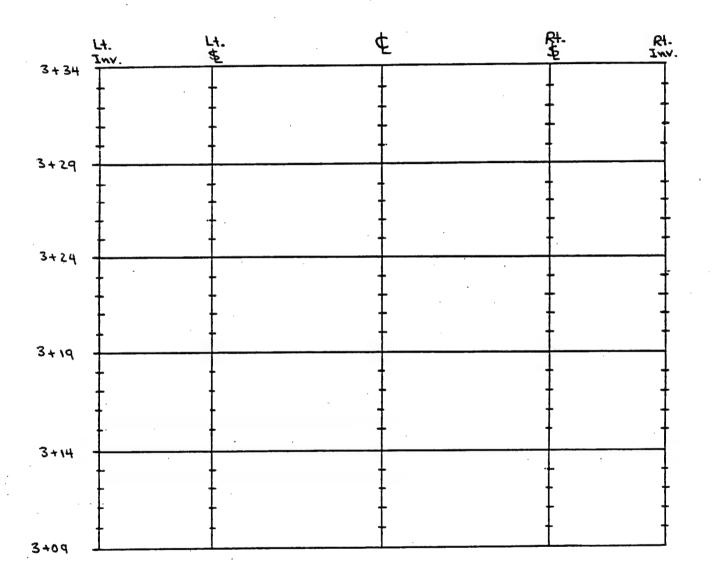


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Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet 9	01 72



Massive Rock No discontinuities

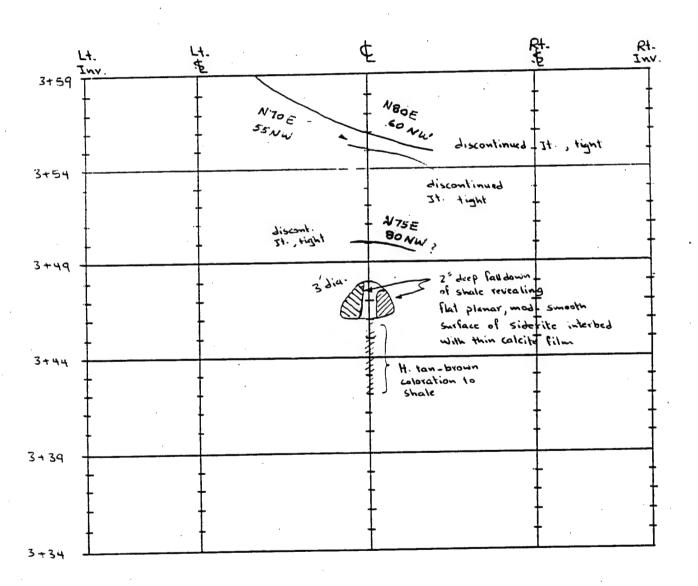
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Subje	ct			Checked	Date
Task	Rock:	New Providence	shale / emkaroson	Sheet 10	or 72



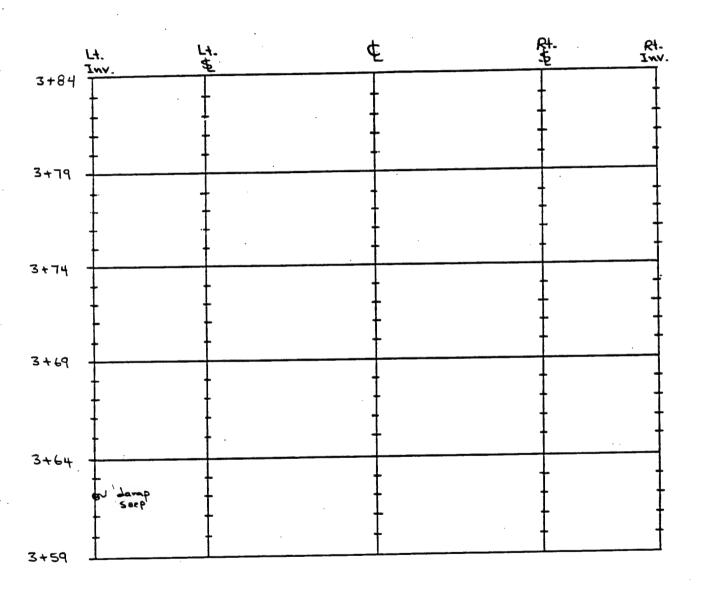
Massive New Providence Shale formation with no discontin.

Job No.	140

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Subj	ect					Checked	Date
Tack	Rock:	New Providence	Shale	/	cottoneans	Sheet 11	01 72

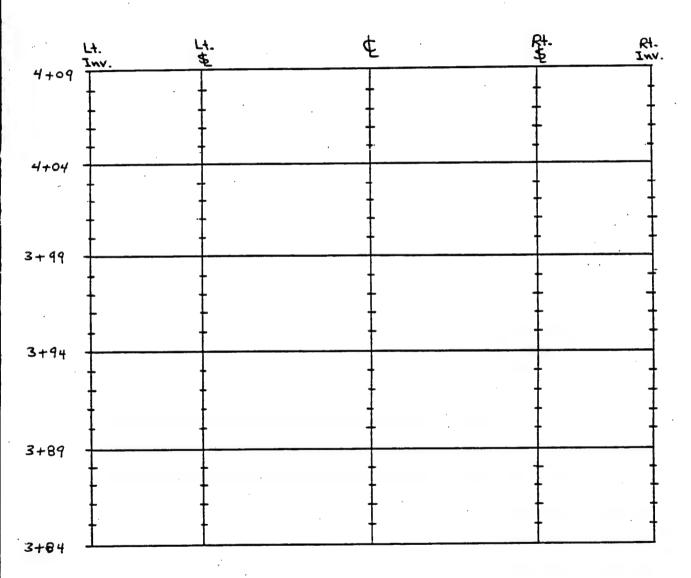


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Task Roc	k: New Providence shale / commonas	Sheet 12	0172



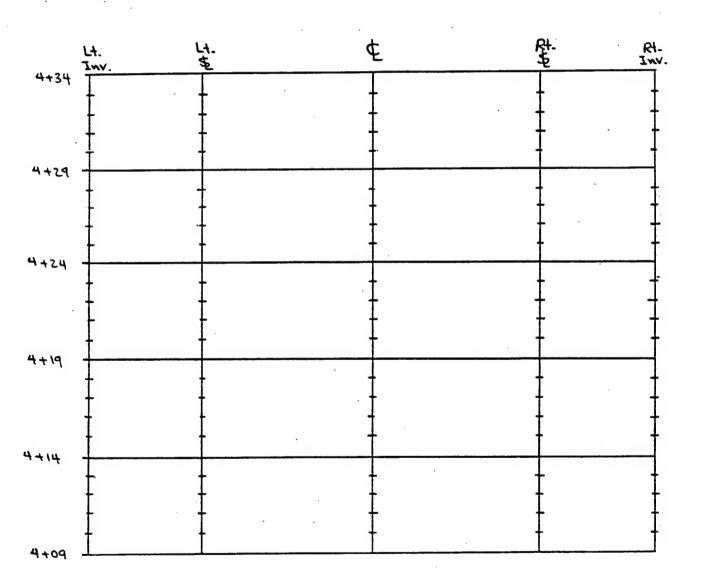
Massive Rock W/no Joints

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Subject	Checked	Date
Text Rock: New Providence Shale / waters	Sheet 13	01 72



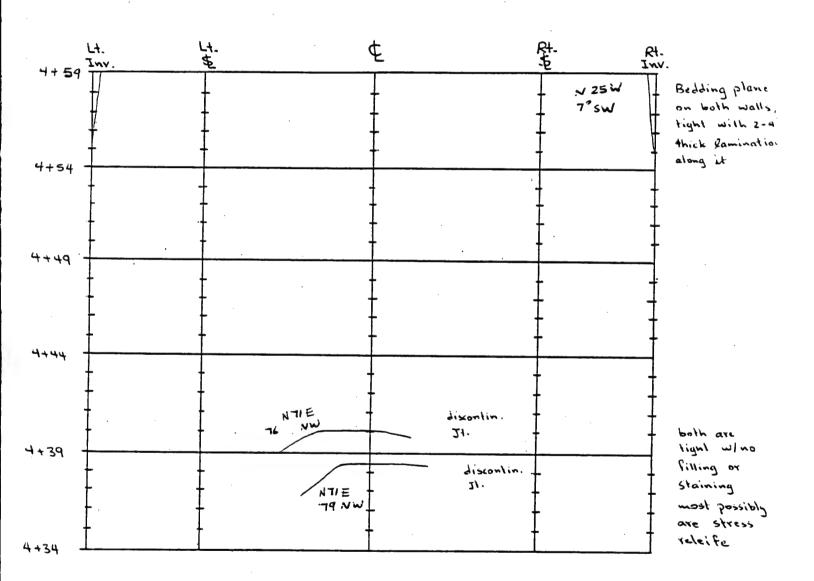
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Subject	Checked	Date
Test Rock: New Providence Shale	Sheet 14	or 72

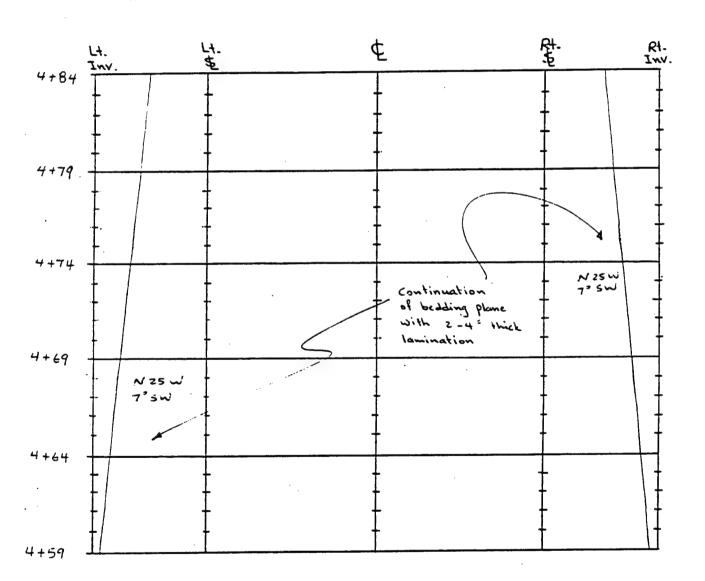


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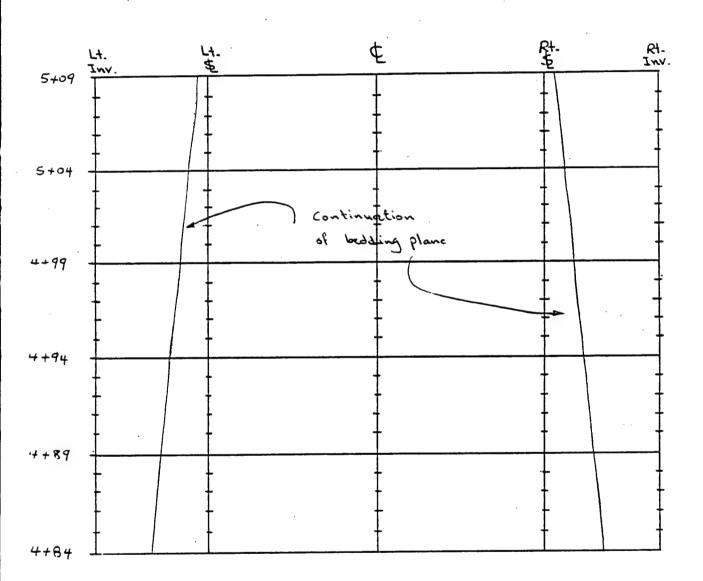
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Subject	Checked	Date
Took Rock: New Providence Shale	Sheet \5	of 72



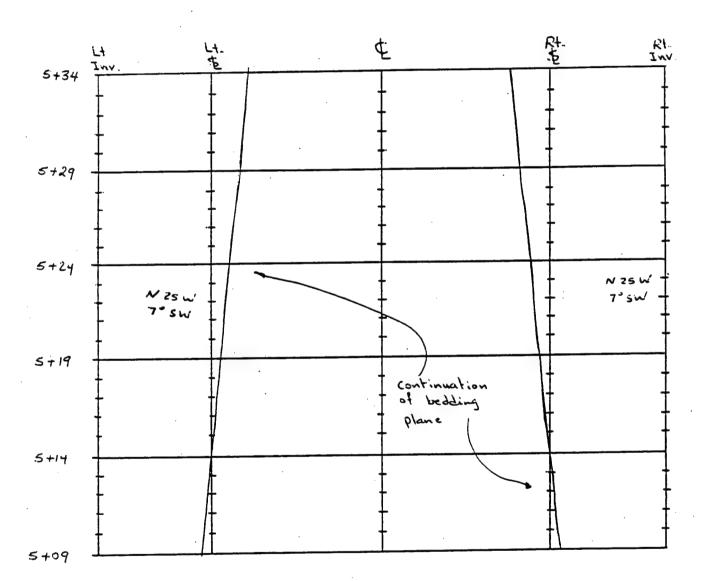
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Tank Rock:	New Providence	Shale	/ dokumenas	Sheet 16	or 72



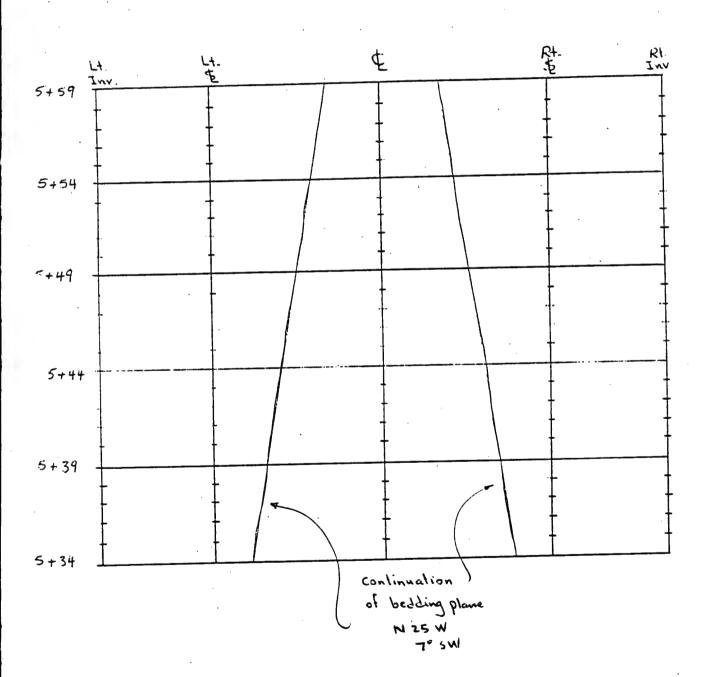
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Subject			Checked	Date
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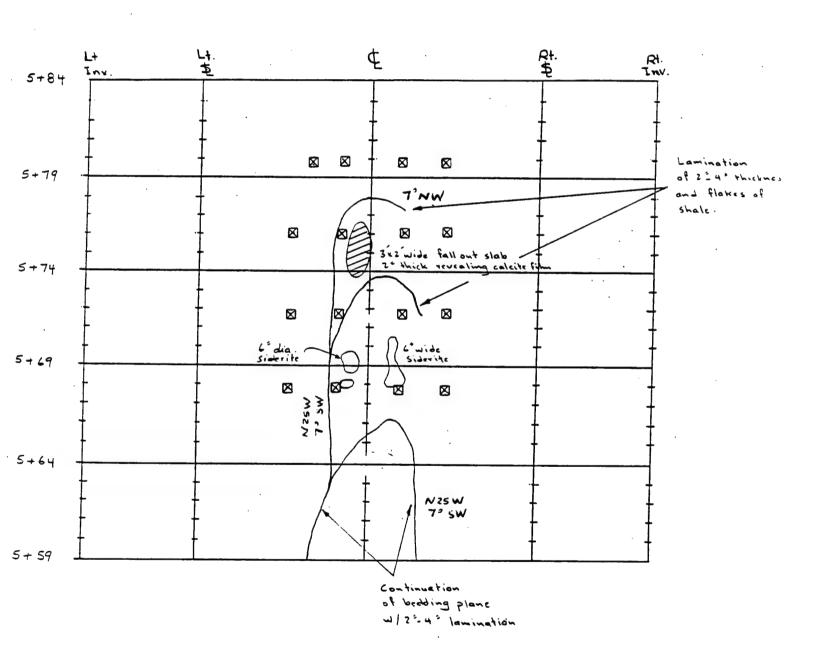
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Tank Rock	: New Providence Shale / concareous	Sheet 18	Of 72



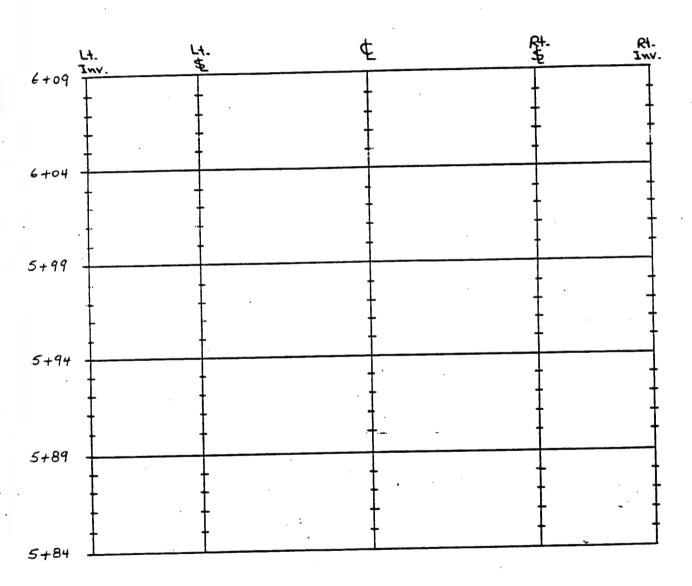
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Task	Rock: New Providence Shale / Rahenreans	Sheet 19	of 72



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	Subject Geologie Ma	pping	Checked	Date
Į	Took Rock: New Pro	ovidence Shale	Sheet ZO	01 71

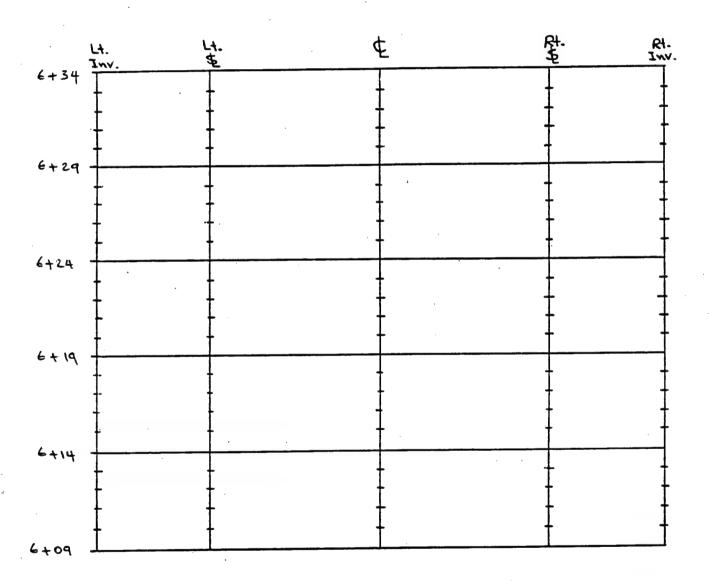


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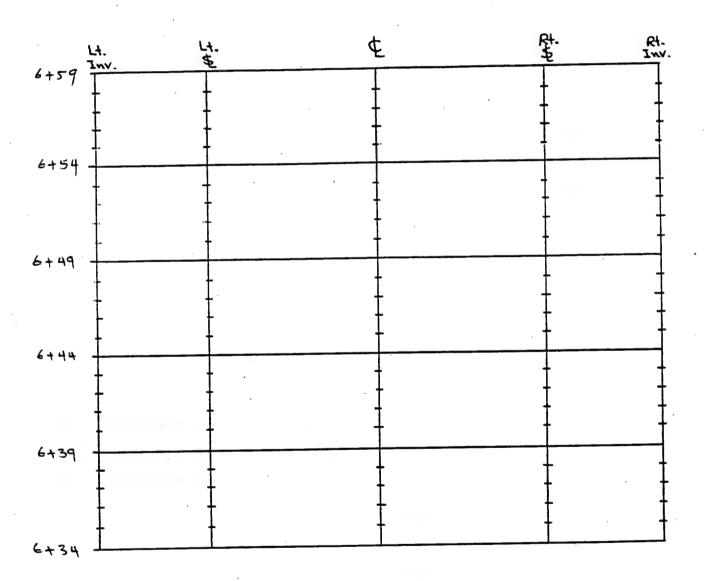
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W/no Joints

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Subject		_		Date
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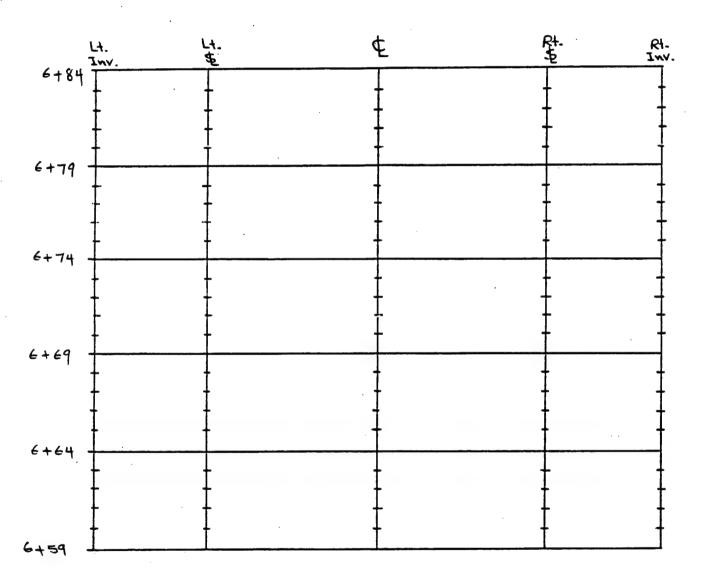
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Subject	Checked	Date
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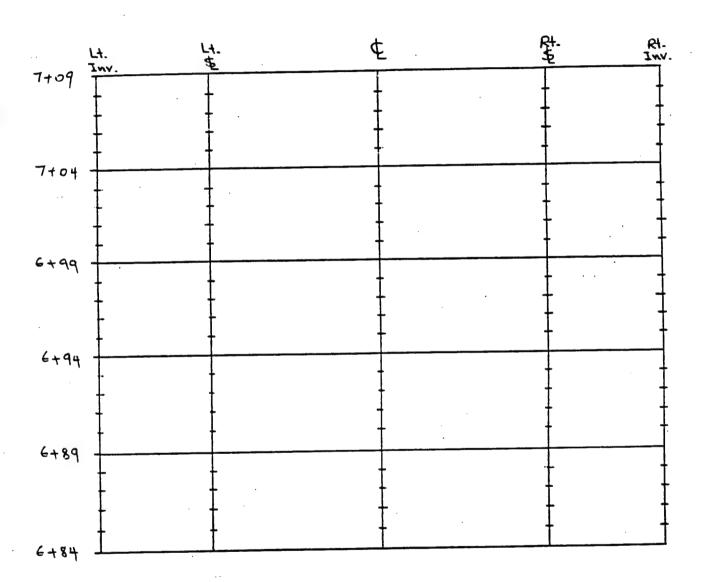
Massive Rock No Joints

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Subject	Checked	Date
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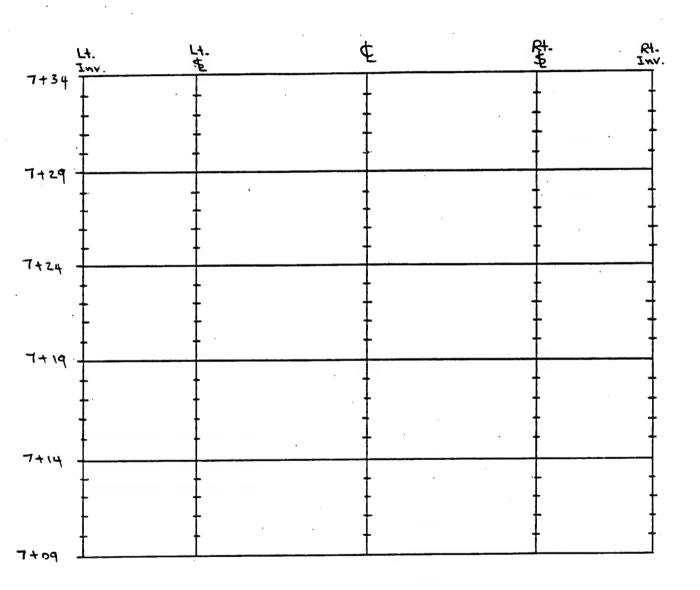
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Subject	Checked	Date
Task New Providence Shale / Outraineous	Sheet 25	or 72



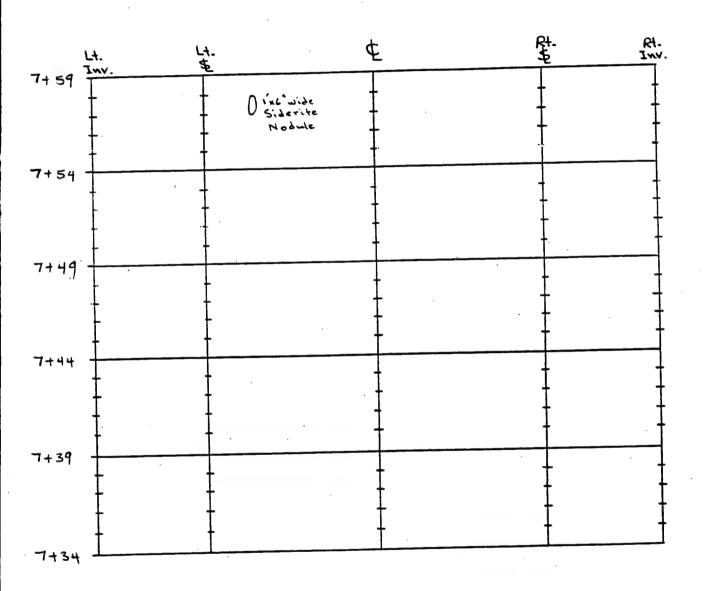
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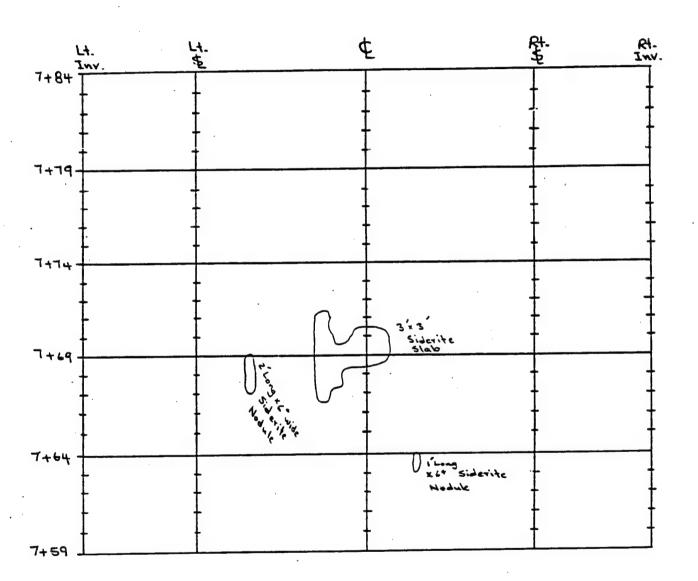
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	Checked	Date
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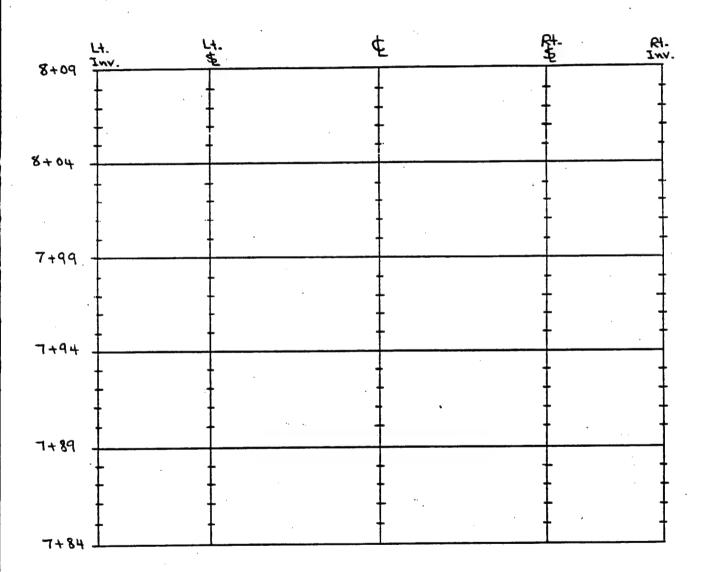
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Subject	Checked	Date
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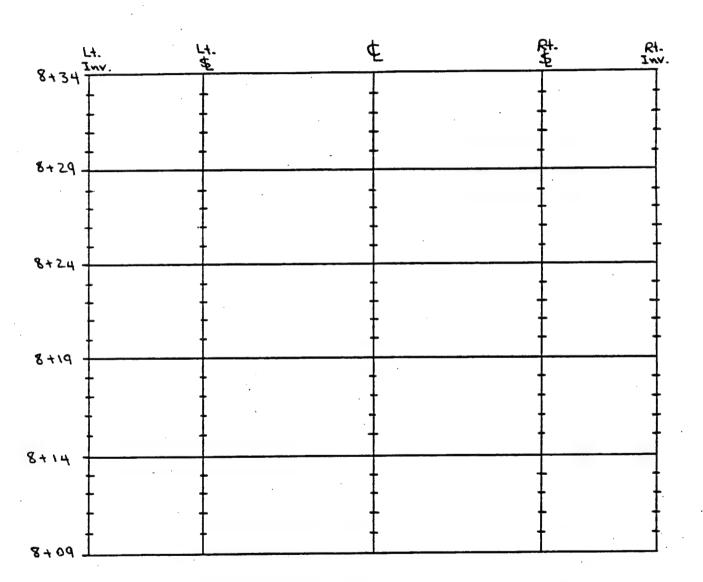


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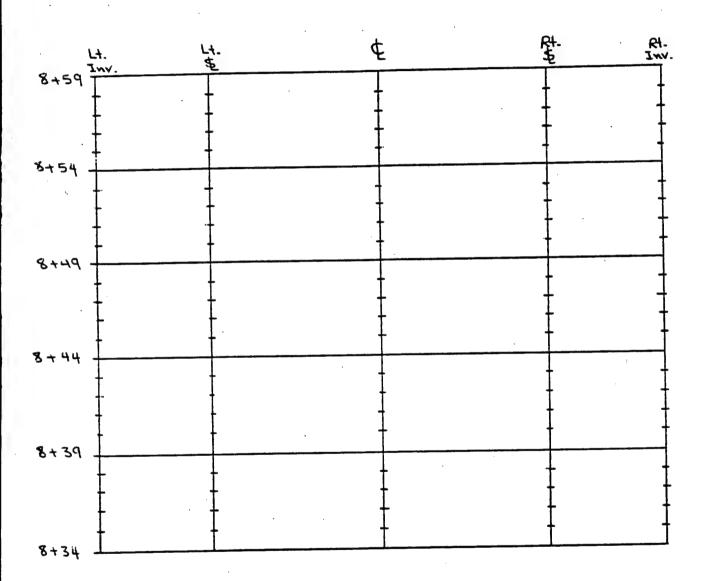


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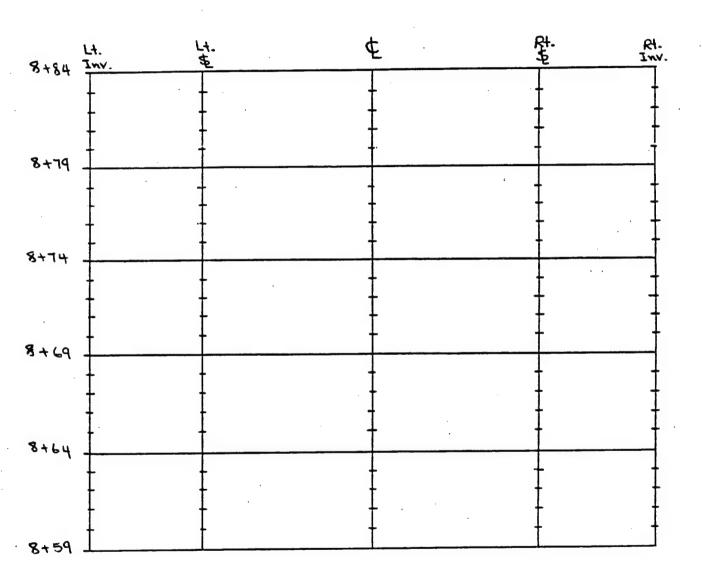


Massive Rock

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Charlest	
Subject Checked Date	
Tot Rock: New Providence Shale Sheet 31 Or 72	

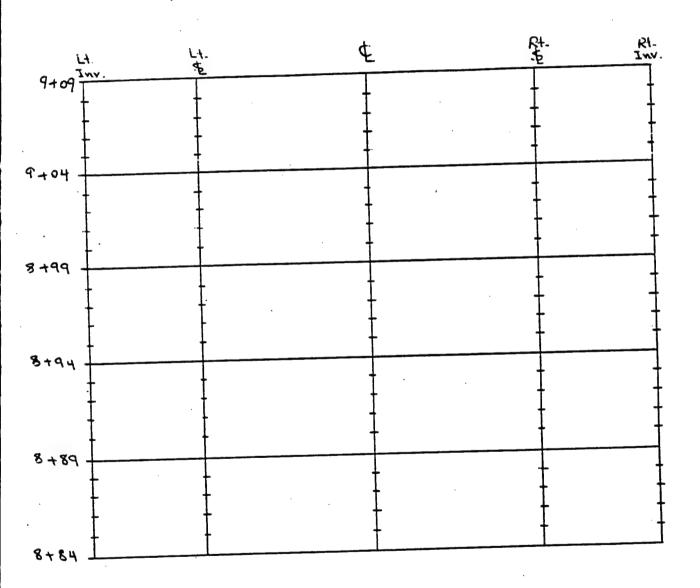


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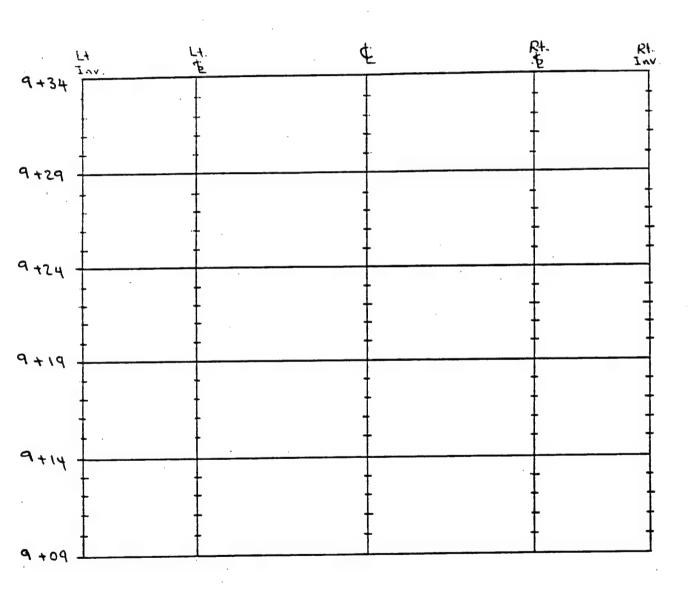
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Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 33	01 72



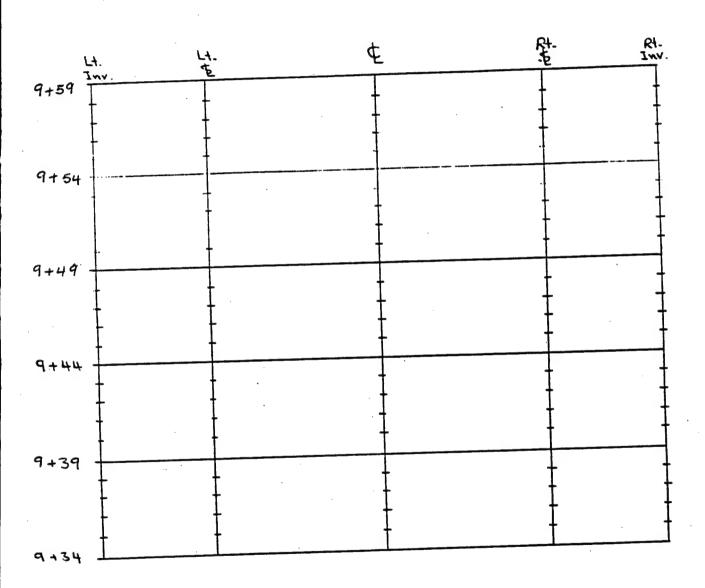
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Tank	Rock : New	Providence Shale	Sheet 34	01 72



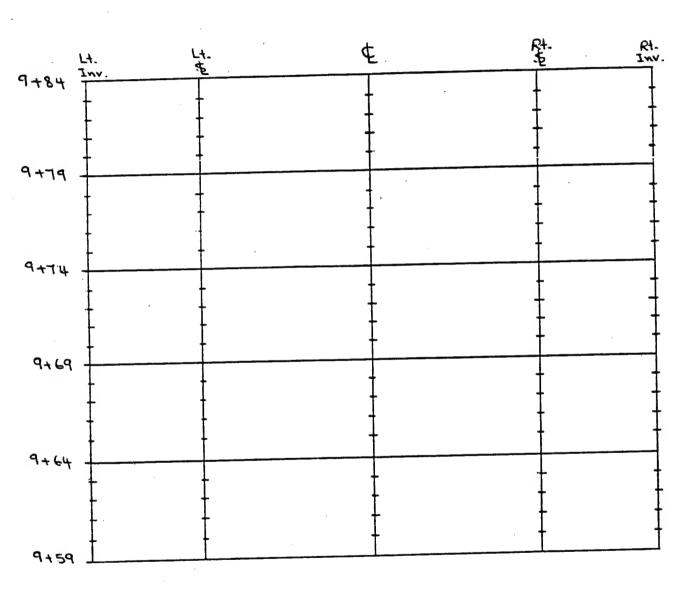
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Project UTP	Computed	Date
	Checked	Date
	Sheet 35	of 72



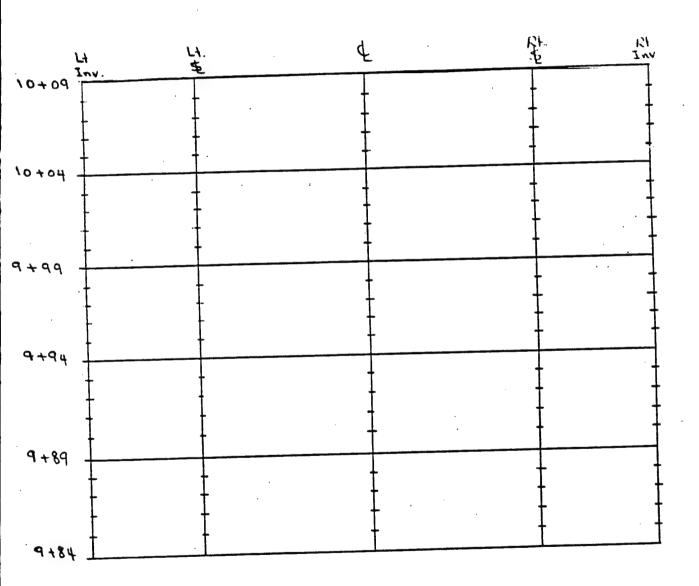
Massive Rock

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Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 36	or 72

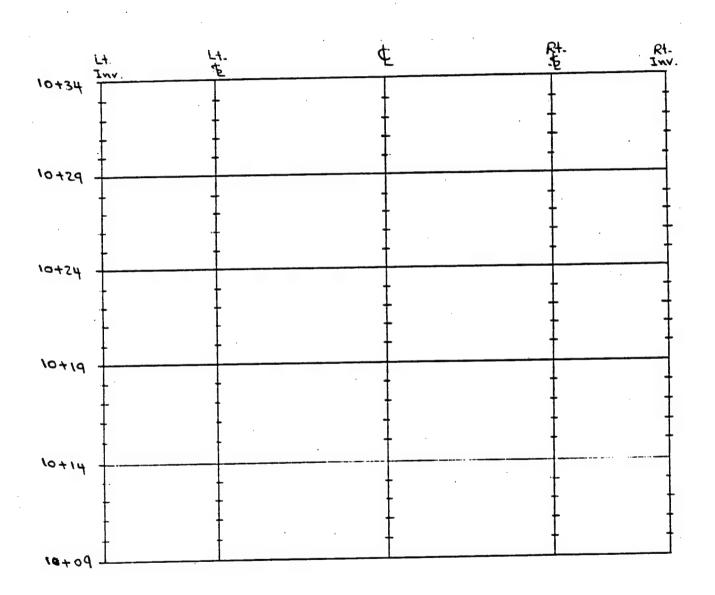


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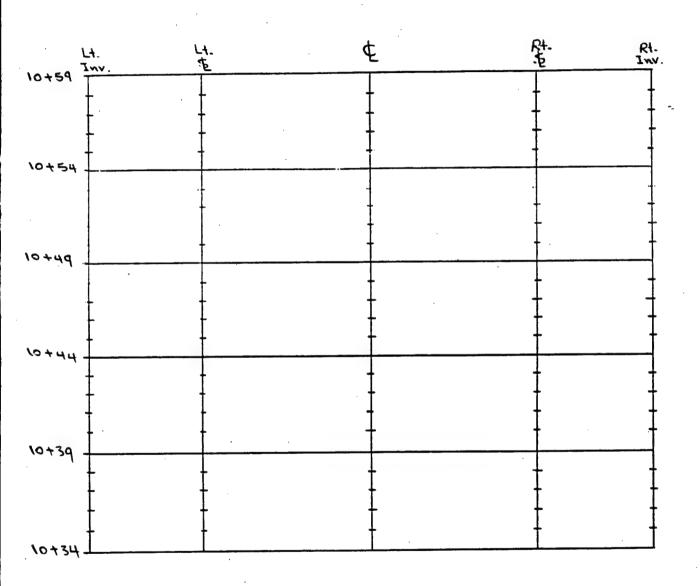
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Subject	Checked	Date
Took Rock: New Providence Shale	Sheet 37	01 72



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Subject	Checked	Date
Task Rock: New Providence Shale s	Sheet 38	01 72

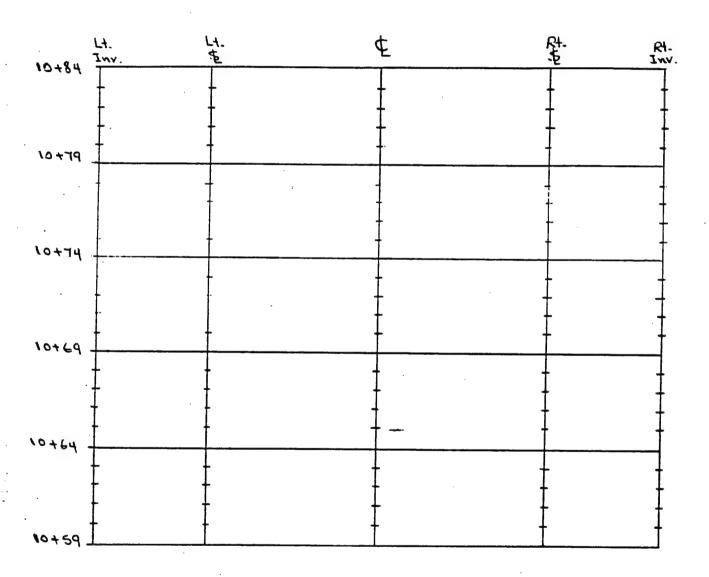


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Took Rock: New Providence shale	Sheet 39	or 72

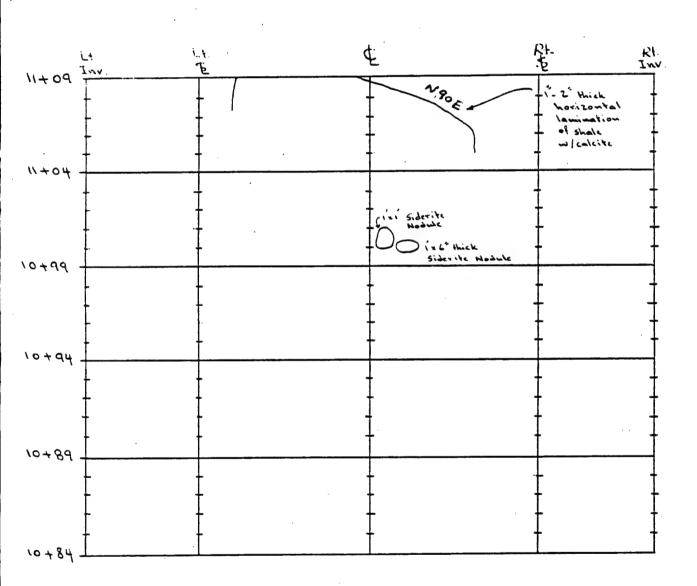


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Tank Pack: Now Providence Shale	Sheet 40	01 72

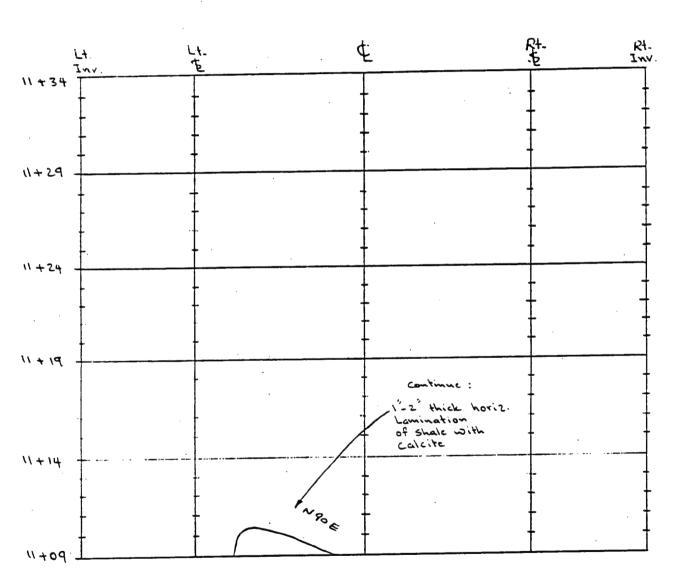


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Subject				Checked	Date
Task	Rock New	1 Providence	Shale	Sheet 41	of 72

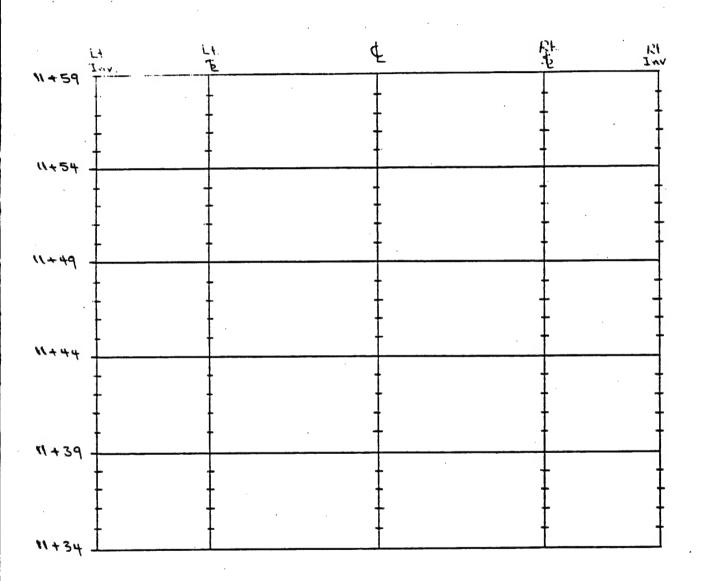


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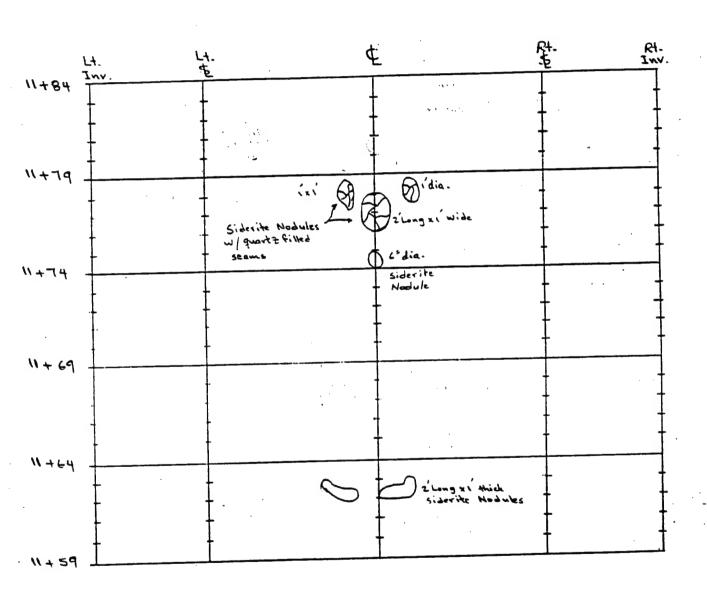
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Task	Rock: N. P. Shale	Sheet 42	oi 72



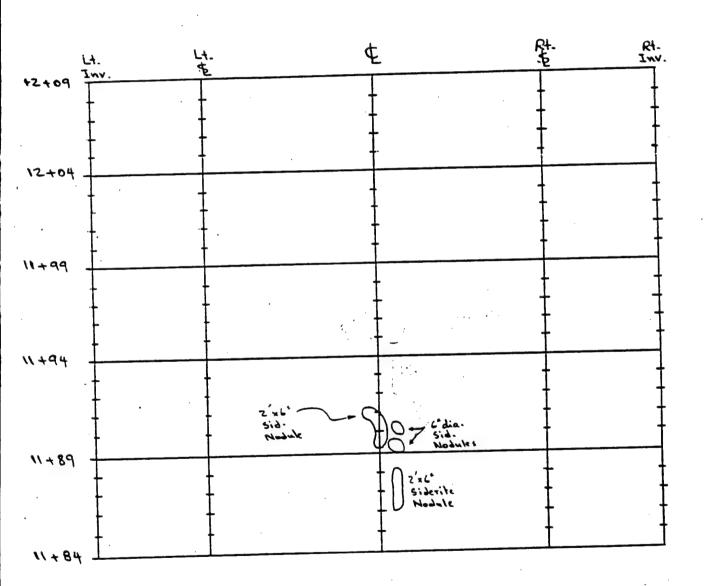
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Subject	Checked	Date
Task Rock: N.P. Shale	Sheet 43	01 72



Project	UTP	Computed	Date
Subject		Checked	Date
Task	N. P. Shale	Sheet 44	or 72



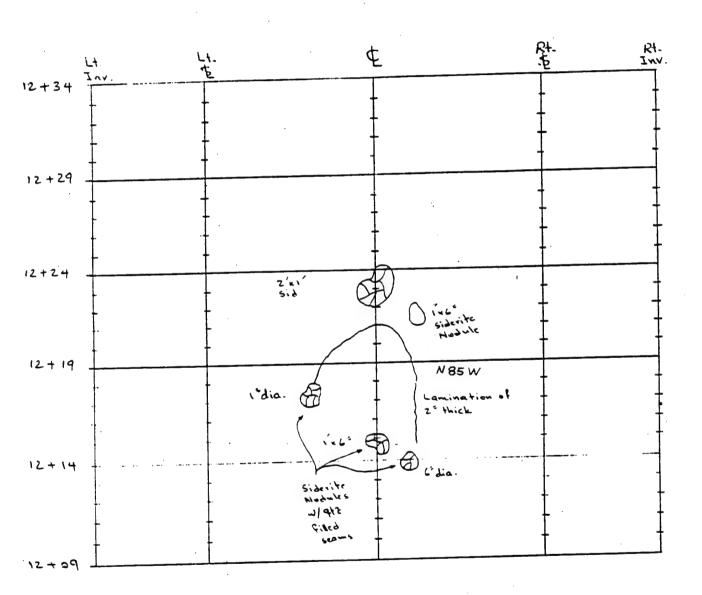
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Subject		Checked	Date
Tack	Rock: N.P. shale	Sheet 45	of 72



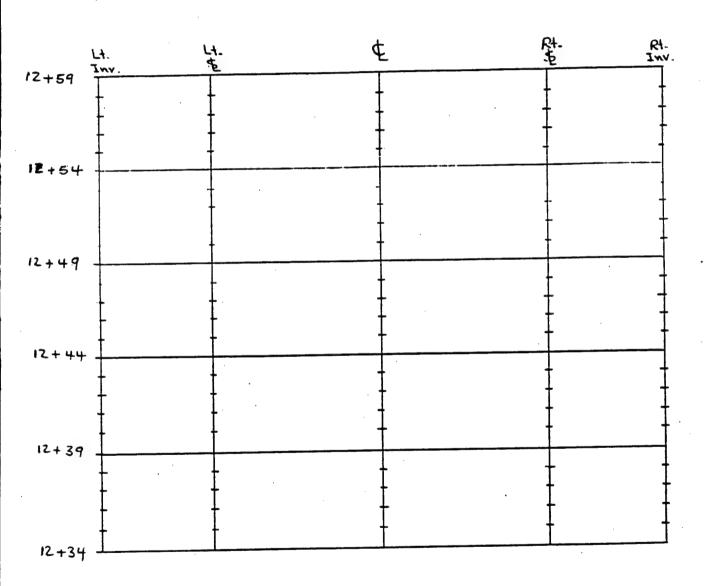
Massive Rock

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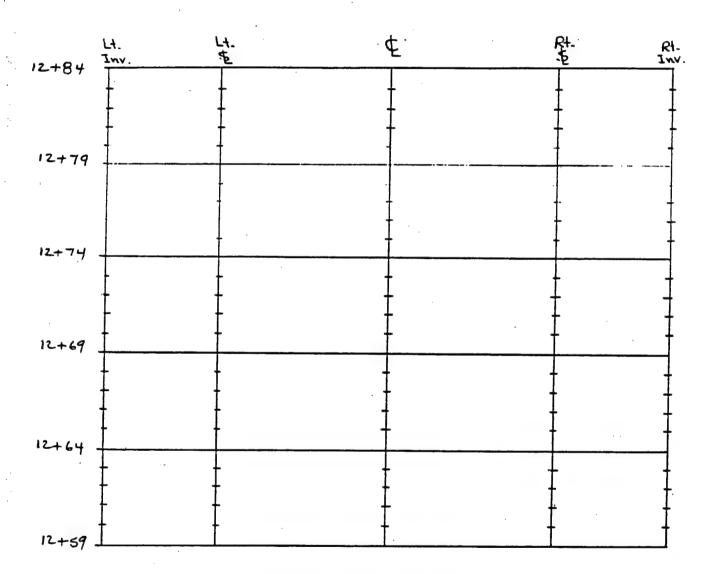
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Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet 4L	01 72



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Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 47	01 72

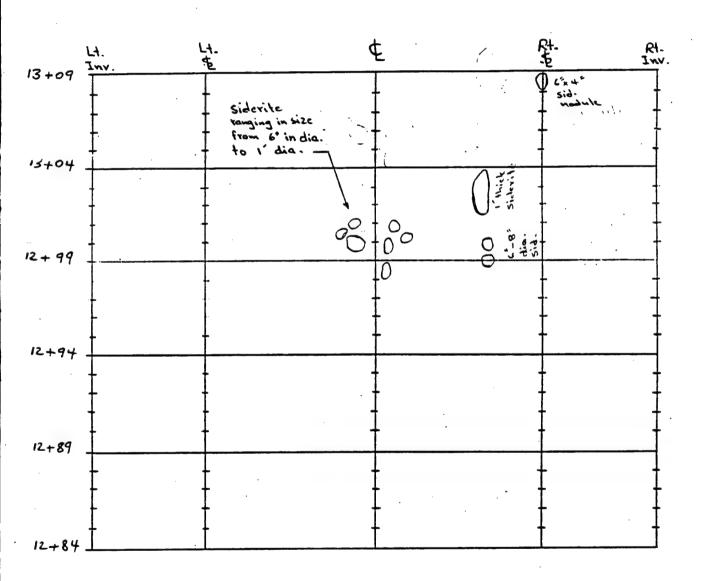


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Subject	Checked	Date
Took Rock: New Prov. Shale	Sheet 48	01 72



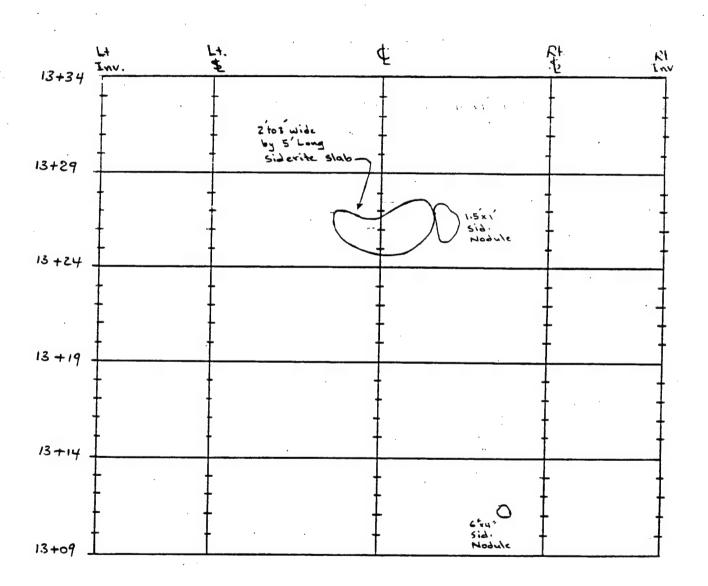
Massive Rock

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Subject	Checked	Date
Took Rock: New Provid Shale	Sheet 49	01 72

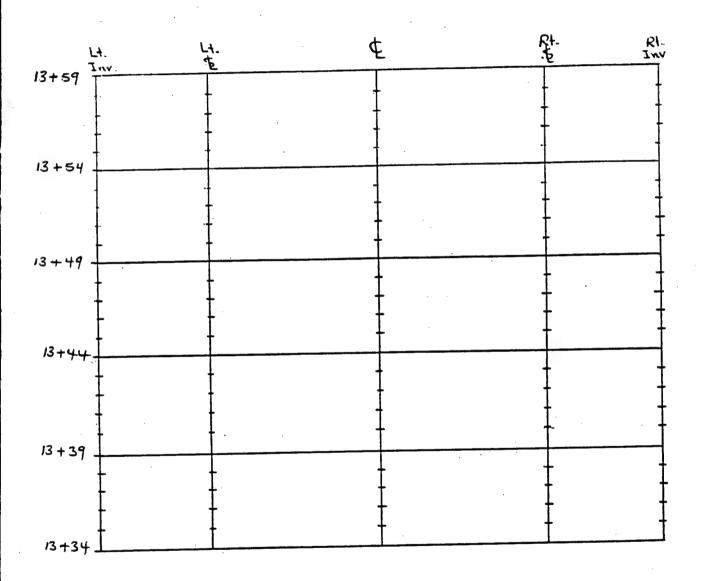


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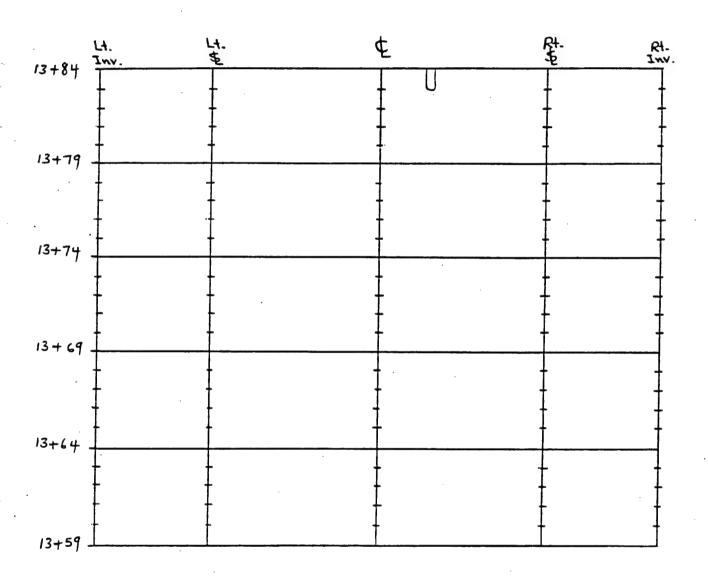
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Subject	Checked	Date
Task Rock: New Providence Shale	Sheet 50	01 72



Project UTP	Computed	Date
Subject	Checked	Date
Total Control Provi Shale	Sheet 51	01 72

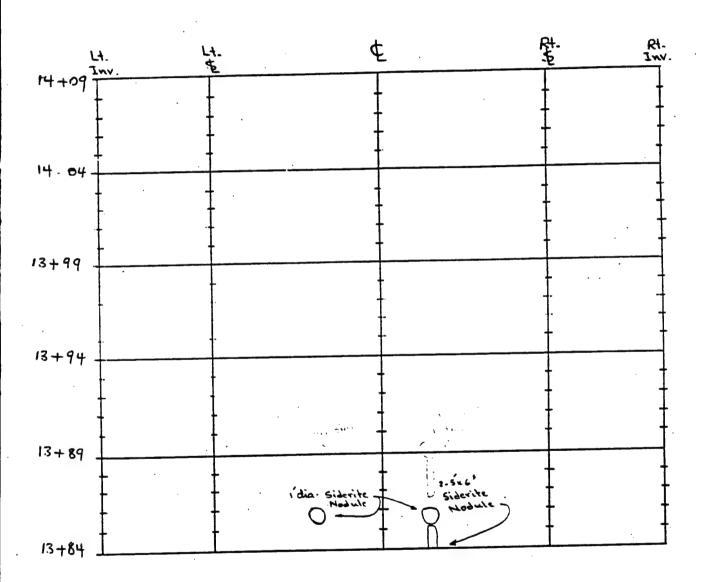


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Subject	Checked	Date
Task Rock: New Prov. Shale	Sheet 52	of 72



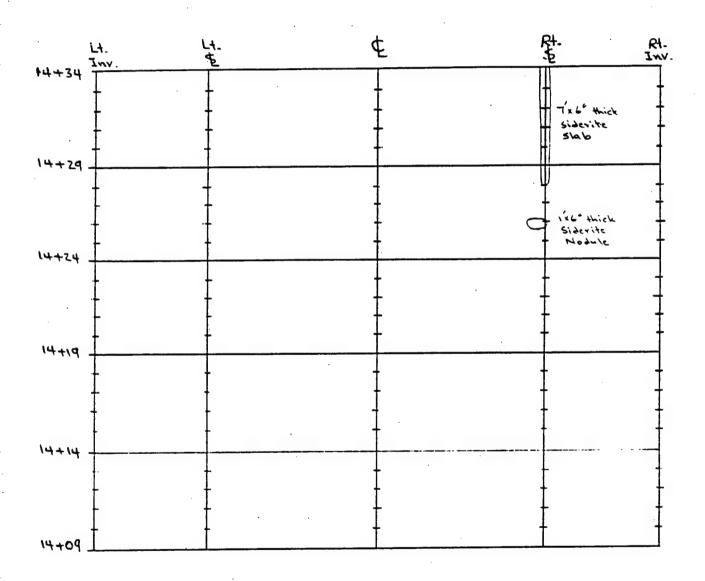
Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Test Pack: New Providence shale	Sheet 53	or 72



Massive Rock

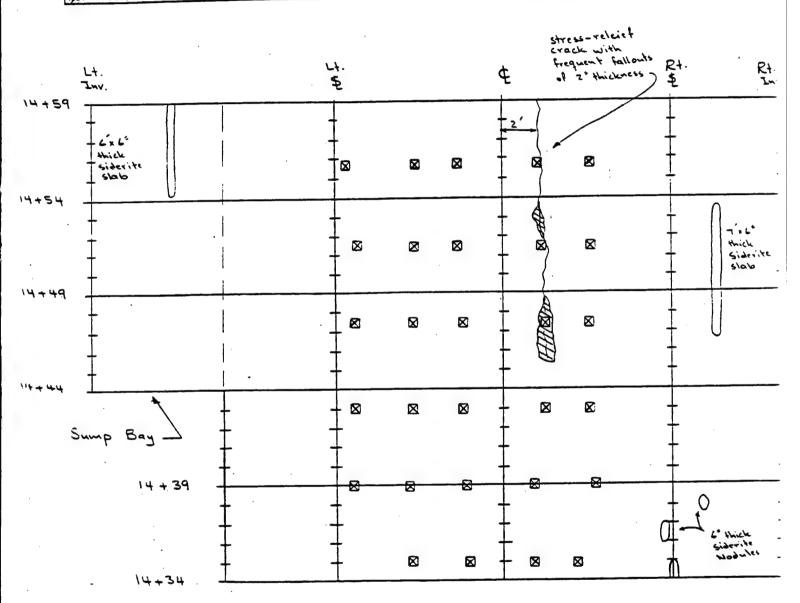
Project UTP	Computed	Date
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Tot Pack: New Providence Shale	Sheet 54	or 72



Massive Rock .

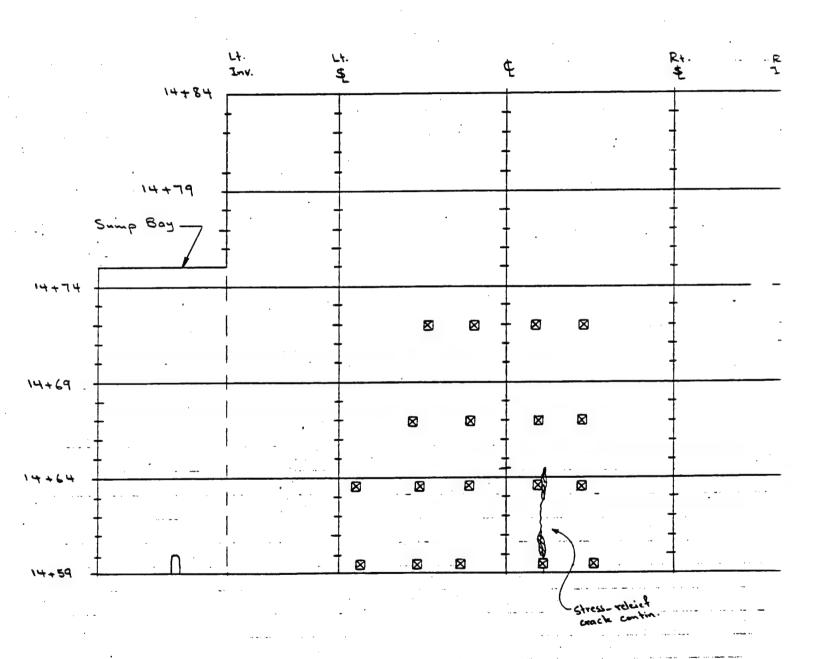
Job No.	 	No	

Project UTP	Computed	Date
Subject Sump Bay-Geologic Mapping	Checked	Date
	Sheet 55	ot 72

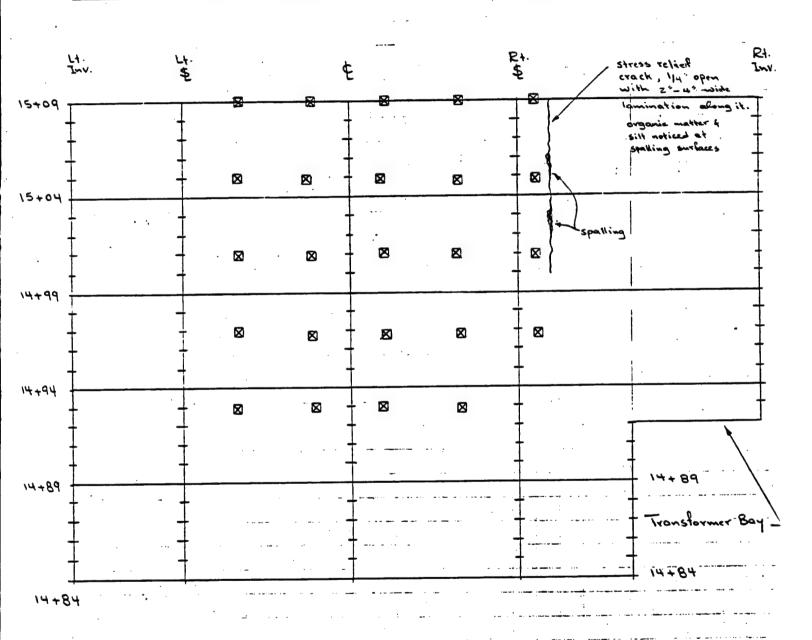


Massive Rock

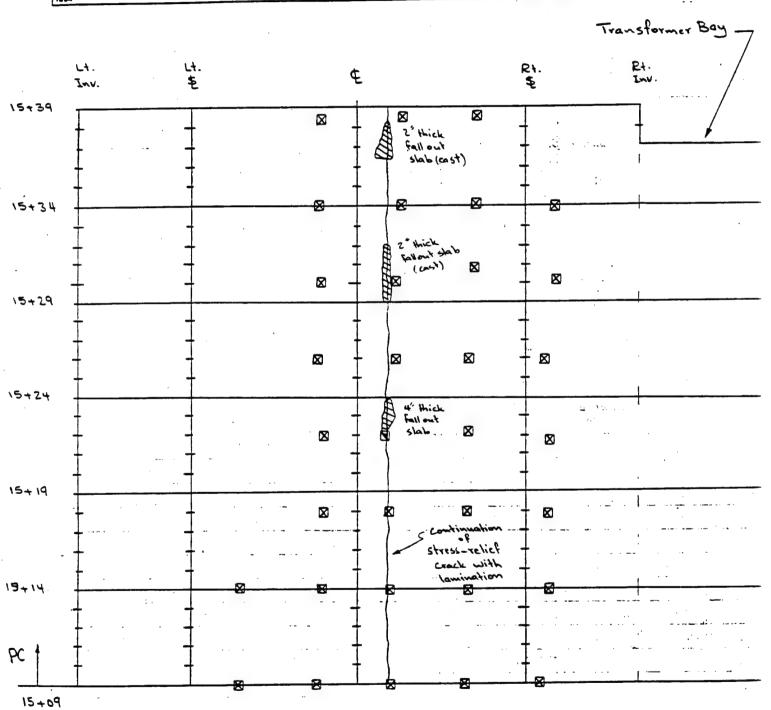
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Project UTP	Computed	Date
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Topa Rock: New Providence Shale	Sheet 57	or 72

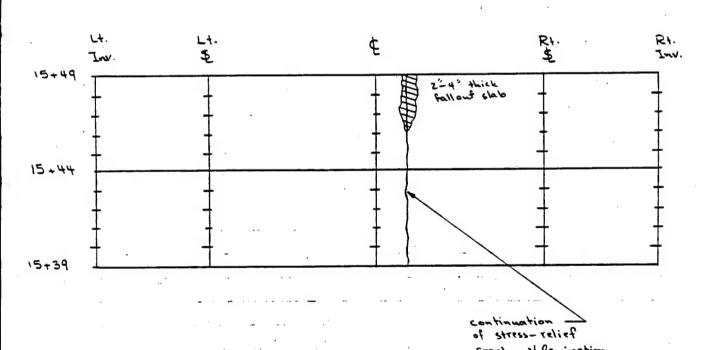


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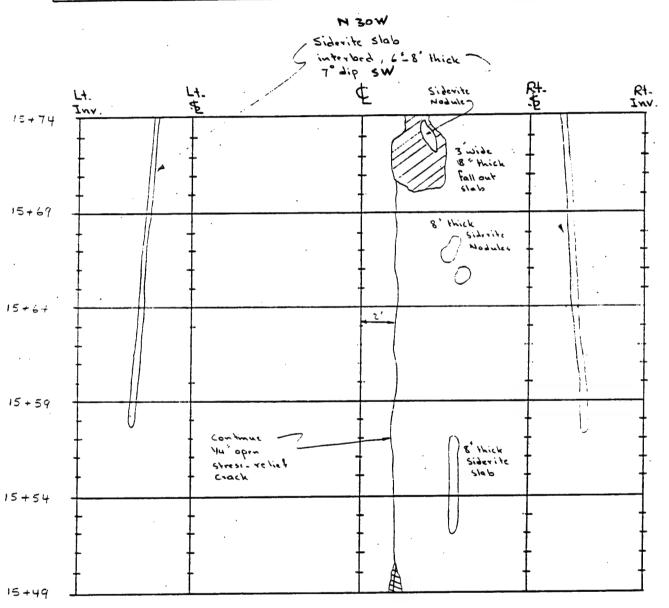
* Tunnel Starts to curve to the left @ Sta. 15+09 (PC)
but curve is not shown here for ease.

Project UTP	Computed	Date
Subject	Checked	Date
	Sheet 59	or 72

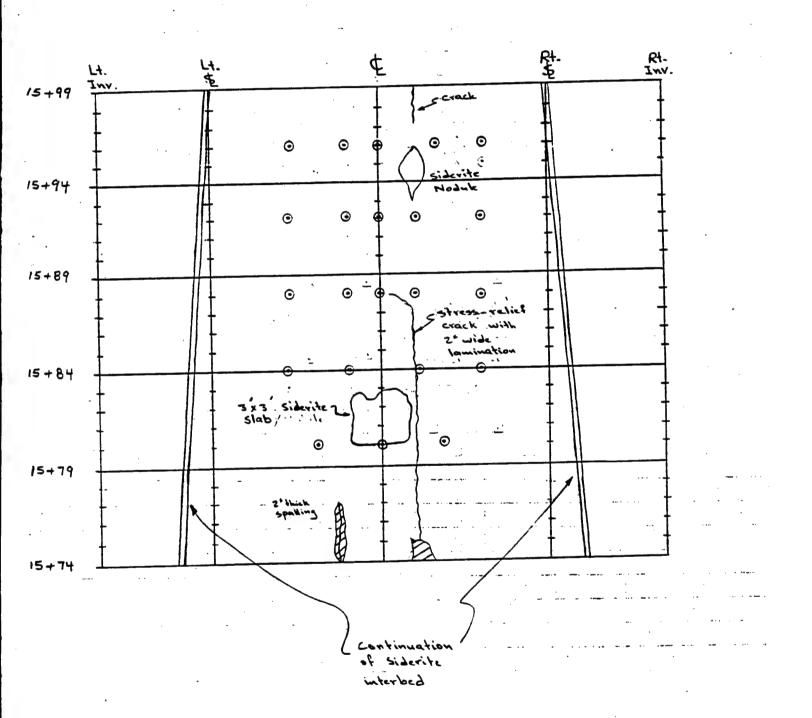


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	Teel	Sheet 62	01 72
. !	M 45 W 9 ° 5 W Bedding plane in Shale m/1" thick Ismination		
(6 4 21	Lt. Lt. E	Rt.	Rt. Inv.
(6 4 2	H 45 W To 5 W Sid. Slab Crack Continues		
16-19			
.6414	••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••<l< td=""><td>-</td><td></td></l<>	-	
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.6404			-

" 6" thick fall out slab w/famination and stress-relief cracks

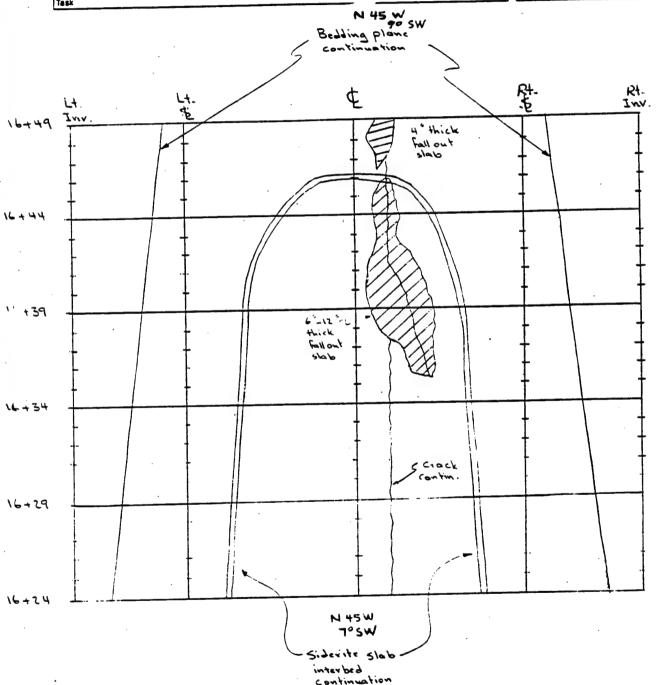
of (al. Adil

Storss-relief Crack, Ilu apen Continues

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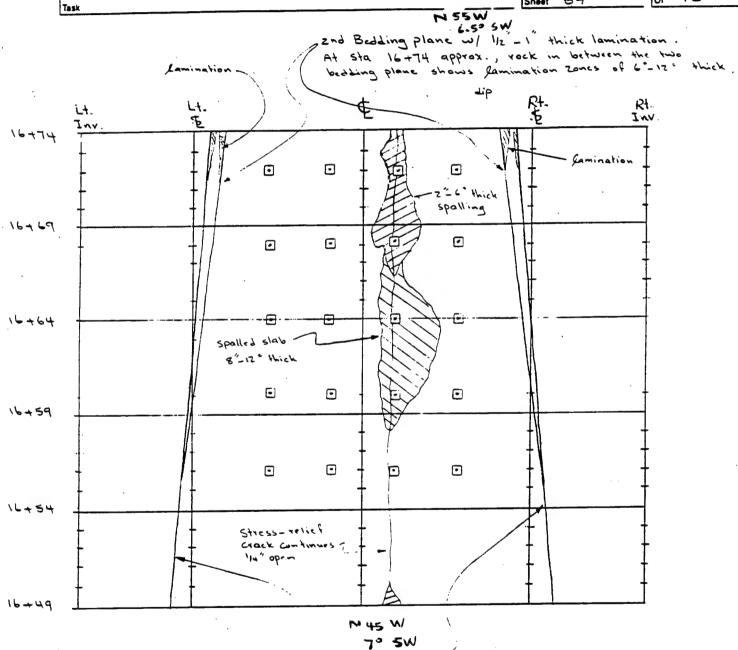
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	Sheet 63	01 72



Notice: Strees relief crack starts developing at 15-20 ft from heading as excavation progresses. Most falling rock start coming down in big chunks at about 20 ft from heading 4 only after 12 to 18 hours of exposure of newly excavated shale.

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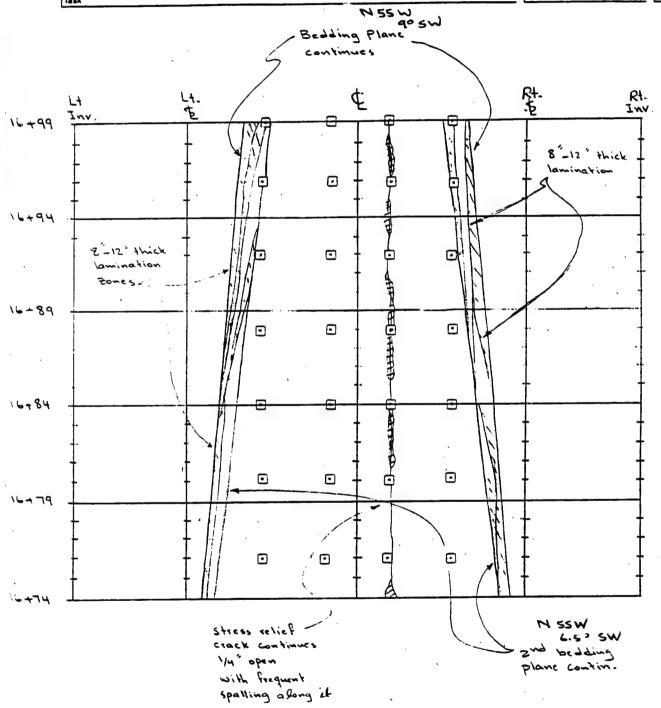
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Subject		Checked	Date
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Bedding Plane continues

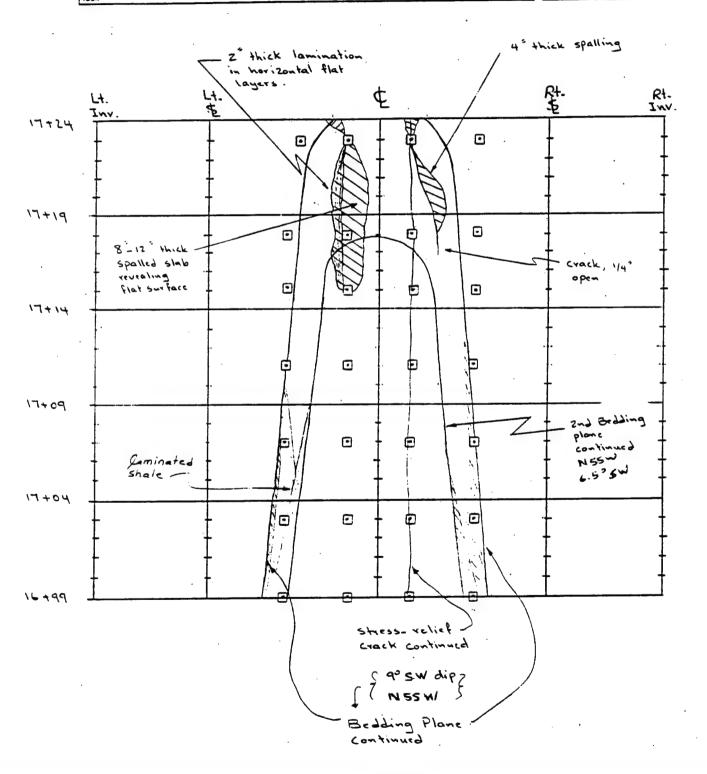
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Job No.	i No.
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Project UTP	Computed	Date
	Checked	Date
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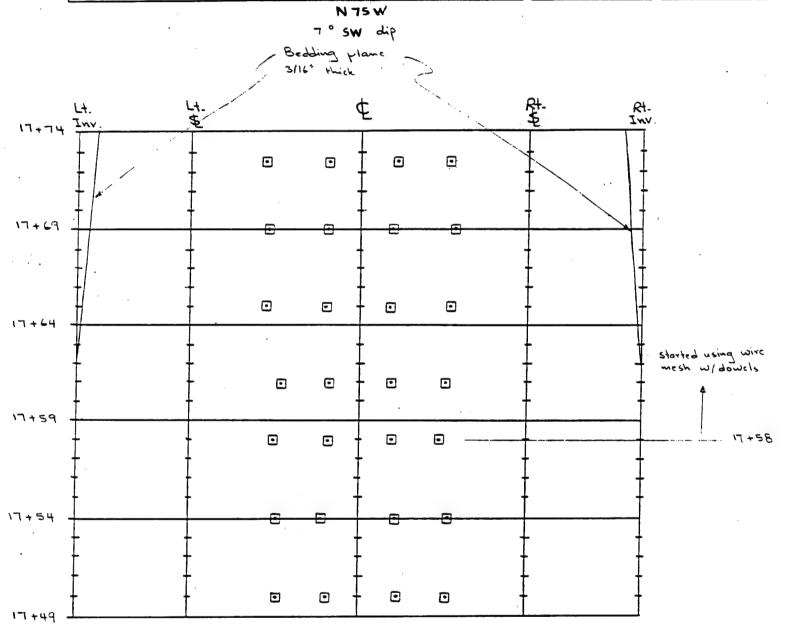


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Project UTP		1
	Checked	Date
Subject		1 72
1	Sheet 67	01 72
Tack		

* New Providence Shale started to change color from dark gray to greenish gray with hues of green & silt-brown banding (layers of coloration) Rt. Inv. L4. \$2 Lt. 17+49 17+46 ✐ 0 ⊡ • 17 +44 . 🖸 ⊡ 0 0 • .0 1-+39 stress-relief Spalling
slab, 2+-3* open. thick • 17+34 ⊡ • 4 - 6 thick Spalling slab 17+29 0 • 0 17+24 continued crack with spaking Bedding Plane disappears into

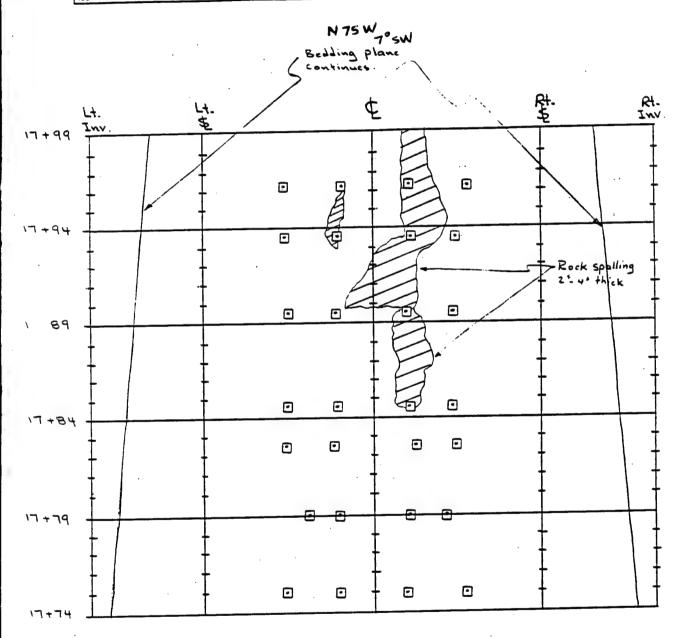
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Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet 48	O1 72

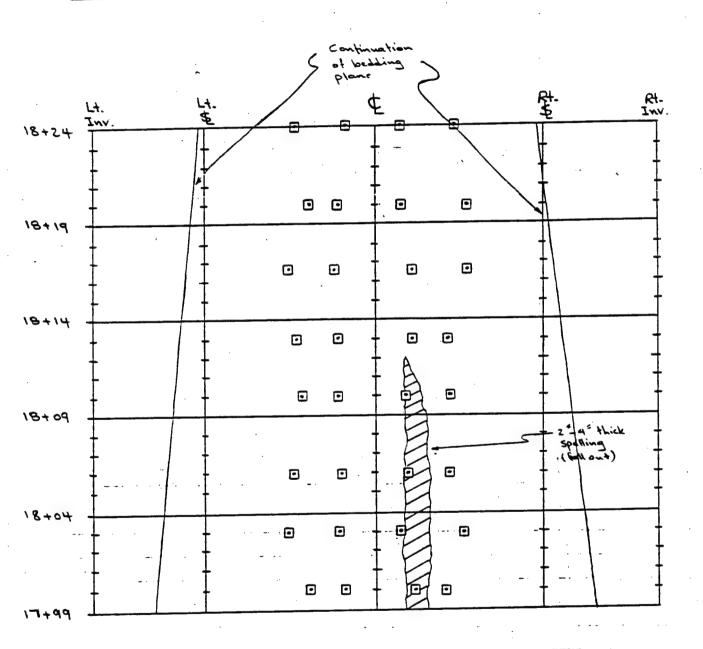


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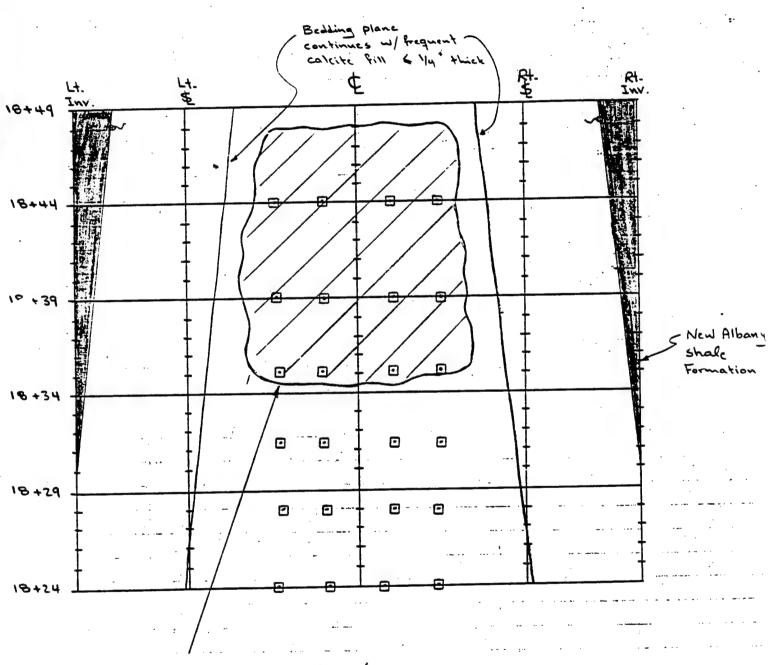
Project UTP	Computed	Date
	Checked	Date
Subject	Sheet 69	Of 72
Task		



Project UTP	Computed	Date
	Checked	Date
	Sheet 70	Of 72



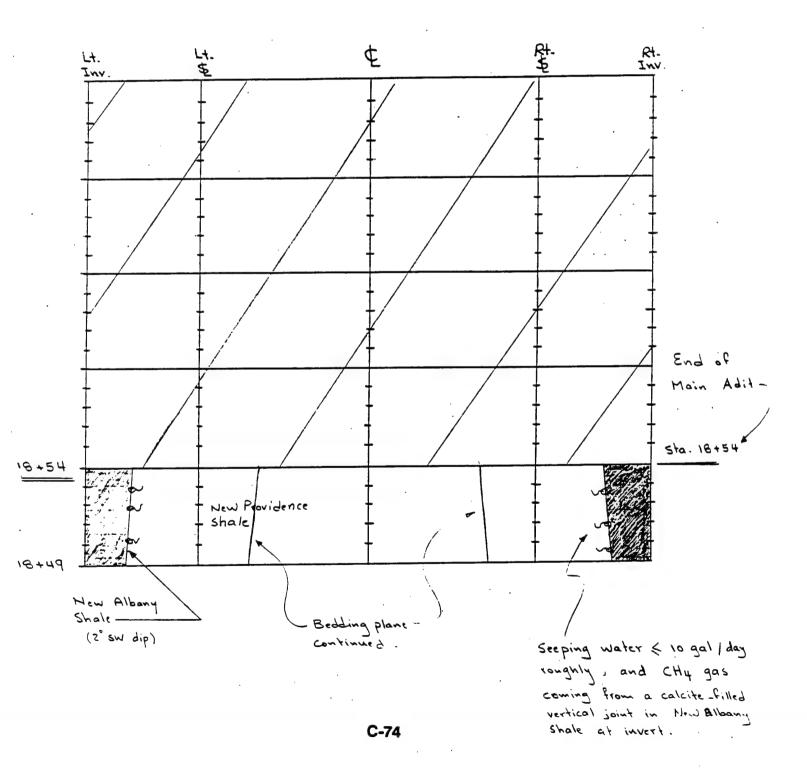
11-70	Computed	Date
Project UTP		
	Checked	Date
Subject		1 -12
	Sheet T\	01 72
Task		



Spalling rock slab, 4-8° thick
fell due to long period of shale
exposure to air (>7 days) without
shotceting, Resulted in flat crown.

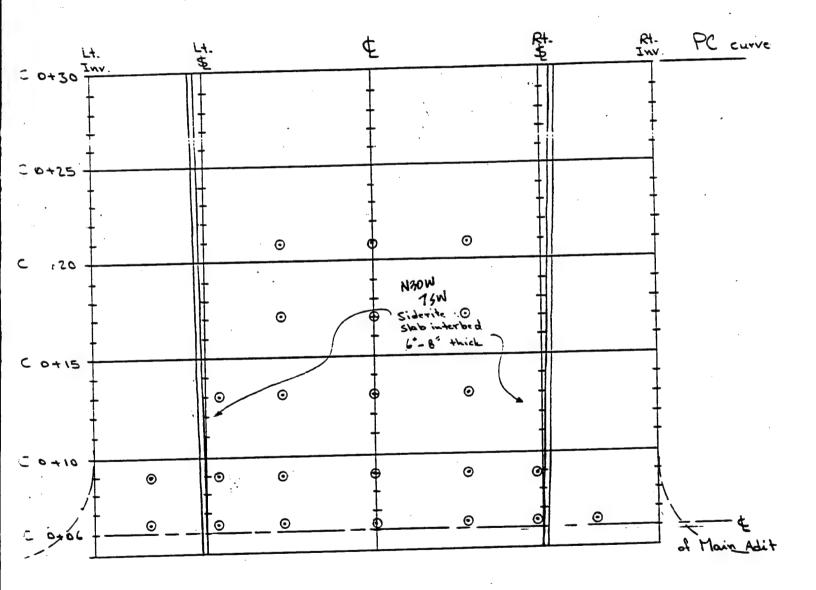
Job No.	No.

Project UTP	Computed	Date
Subject	Checked	Date
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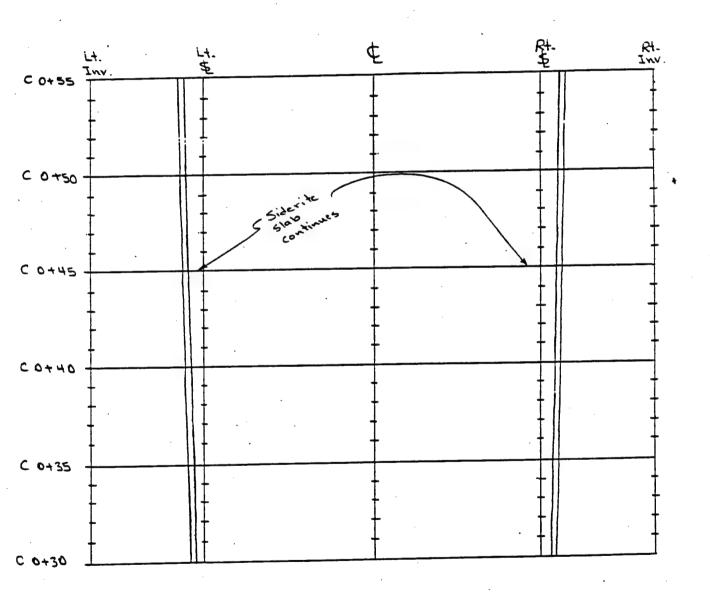
Project VTP	Computed	Date
Subject Geological Mapping of Colib. Adit	Checked	Date
Took Providence shale	Sheet	01 21

Massive Rock



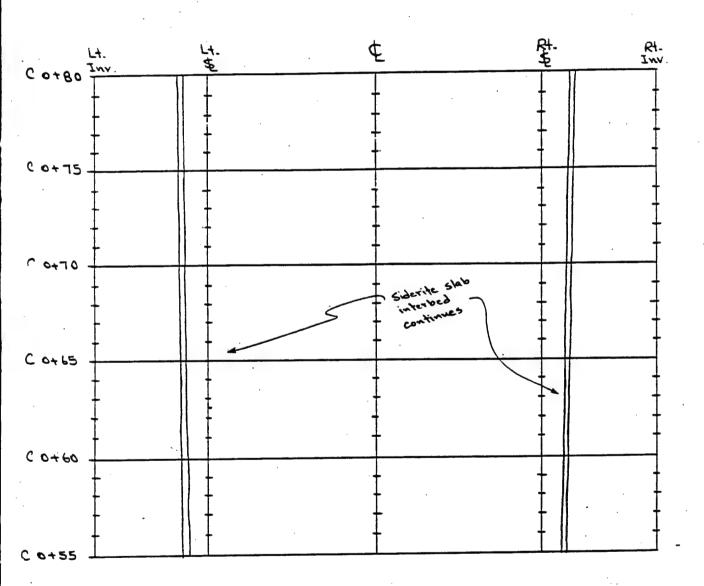
- * Start station of Calibration Adit is C 0+00 @ center of Main Adit @ Sta. 16+00
- * Cal. Adit has a curve; Curve # 2 PC Sta. C 0+30 PT Sta. C 1+34.61

Project UTP	Computed	Date
Subject Geo. Mapping - Cal. Adit	Checked	Date
	Sheet Z	of 21



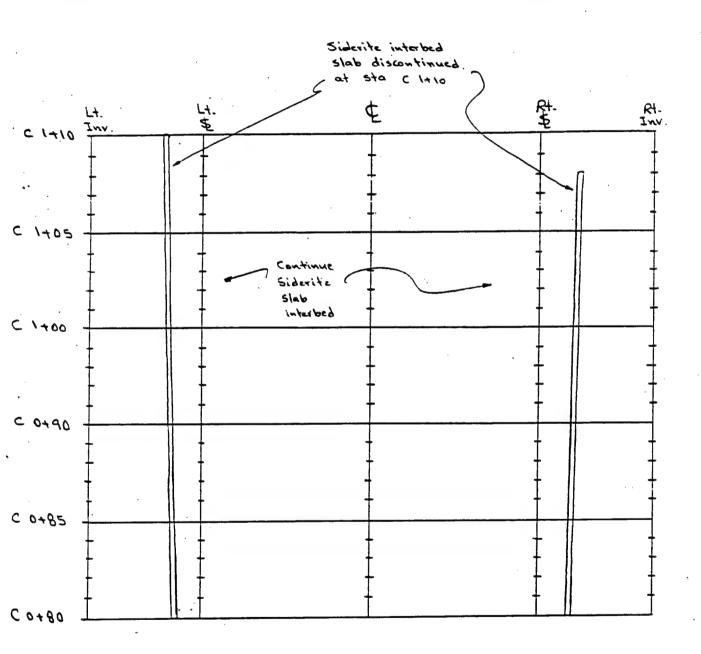
Massive Rock

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task	·	Sheet 3	01 21.



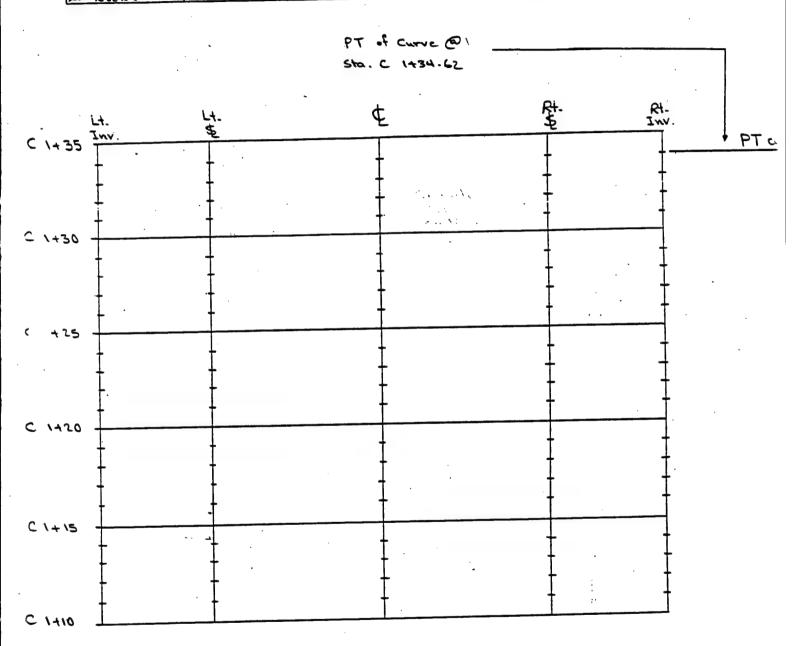
Massive Rock

Project	UTP			 Computed	Date
Subject -	Cal.	4:4	•	 Checked	Date
Task			 • •	Sheet 4	01 21



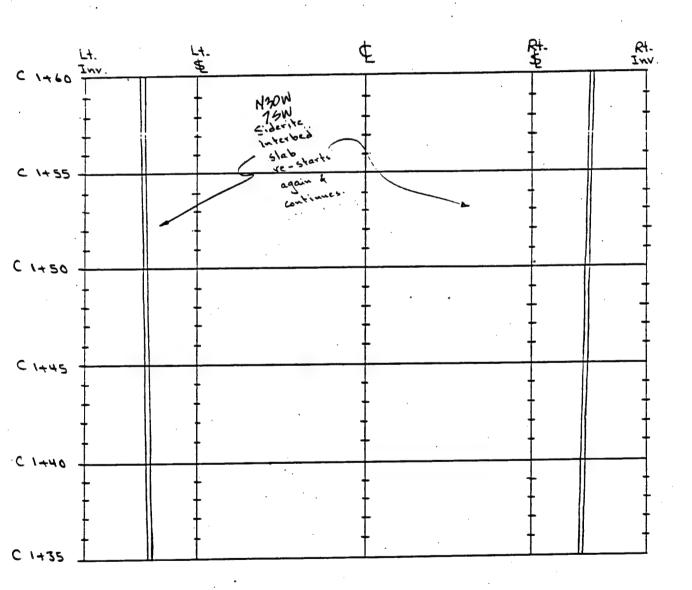
Massive Rock

la	Computed	Date
Project UTP	Checked	Date
Subject Cal, Adit	Checked	Date
Took Pock: New Providence Shale	Sheet 5	01 21



Massive Rock

Project	UTP	Computed	Date
Subject	Cal. Adil	Checked	Date
Task	•	Sheet 6	or 21



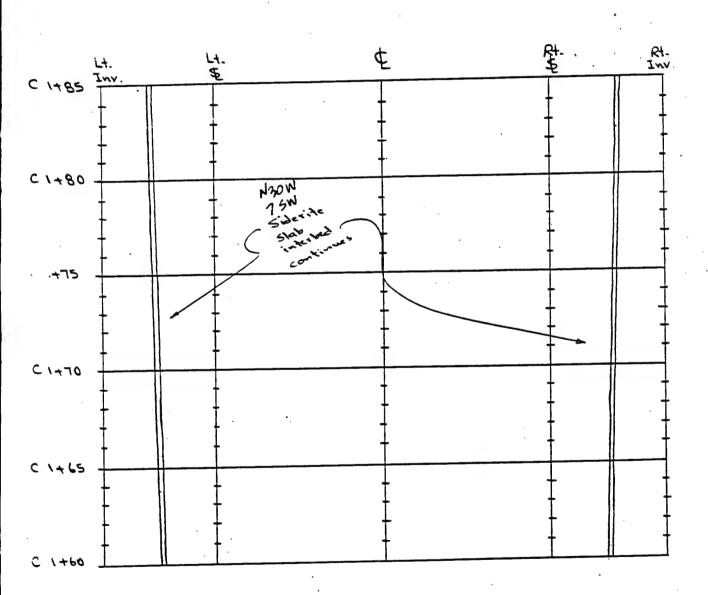
Massive Rock.

* Sta. C 1+34.62 - Sta. C 5+24 (End of Cal. Adit)

Orientation of Cal. Adit = 335° (Ruming Parallel

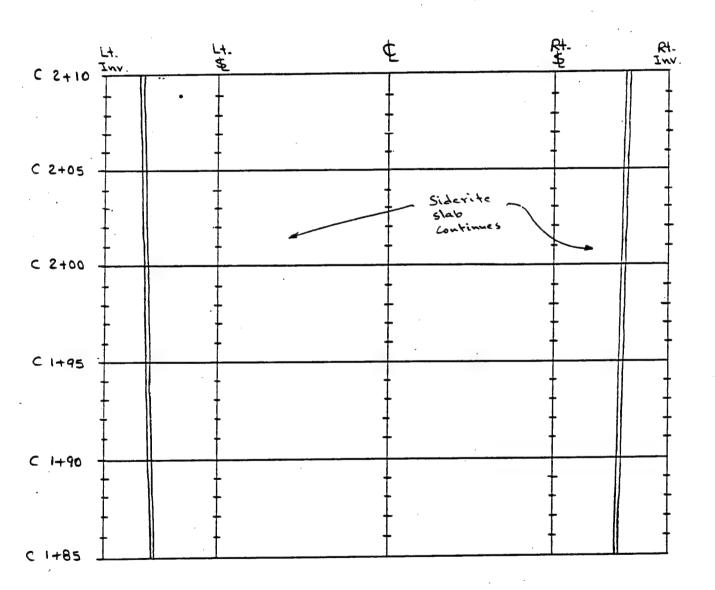
to Main Adit)

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 7	01 21



Massive Rock

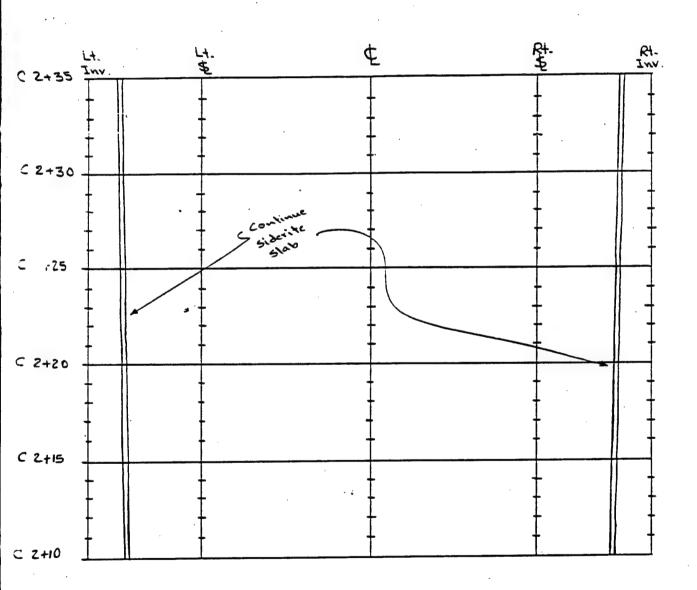
Project	UTP		Computed	Date
Subject	Cal.	4;6A	Checked	Date
Task			Sheet 8	0121



Massive Rock

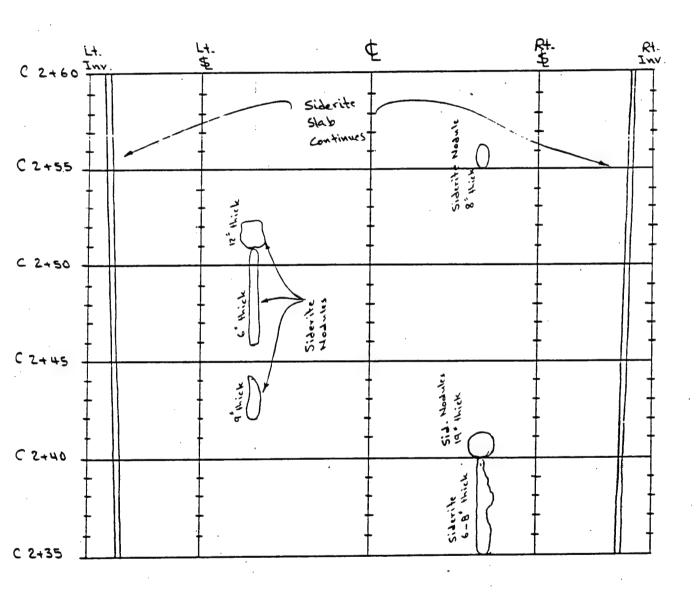
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Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		 Sheet 9	or Z \



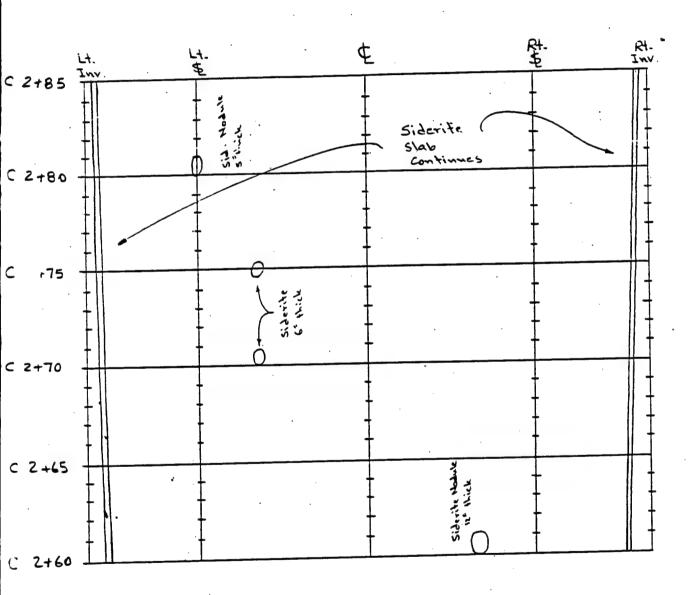
Massive Rock

Project	UTP		Computed	Date
Subject	cal.	Ad; t	Checked	Date .
Task			Sheet \0	or .51



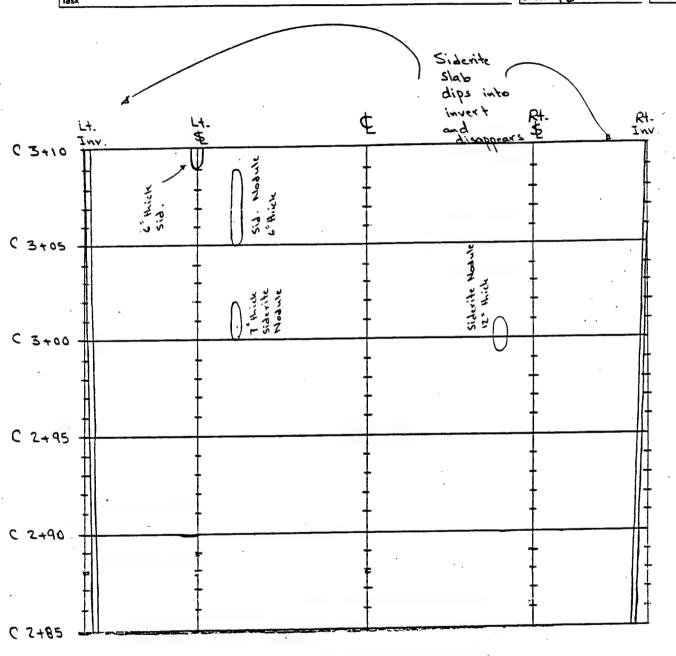
Massive Rock

L 1170	Computed	Date
Project UTP		
1	Checked	Date
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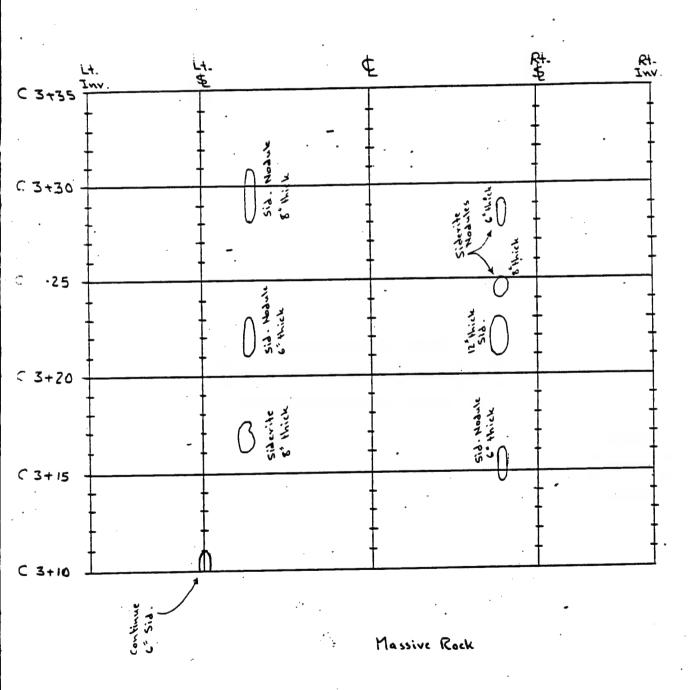
Massive Rock

Project UTP	Computed	Date
Subject Cal. AA:+	Checked	Date
Task	Sheet 12	0 21

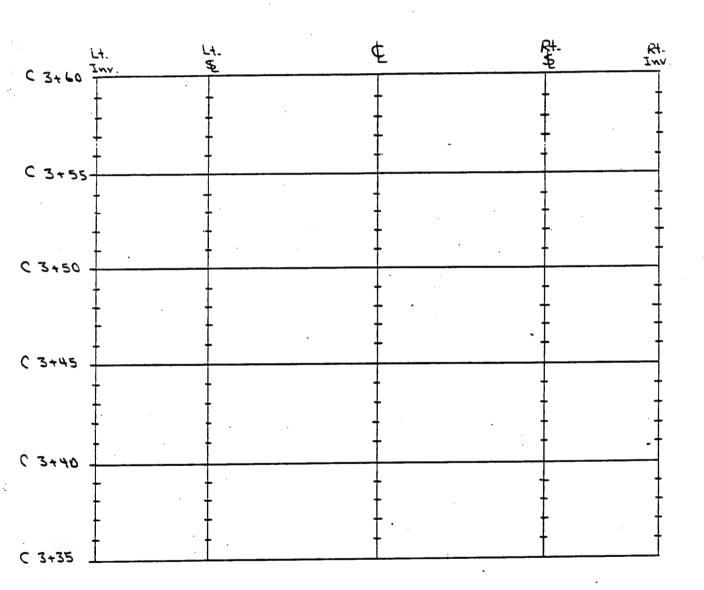


Massive Rock

Project UTP	Computed	Date
Subject	Checked	Date
Task	Sheet \3	01 21



Project UTP	Computed	Date
Subject Cal Adit	Checked	Date
Task	Sheet 14	of 21

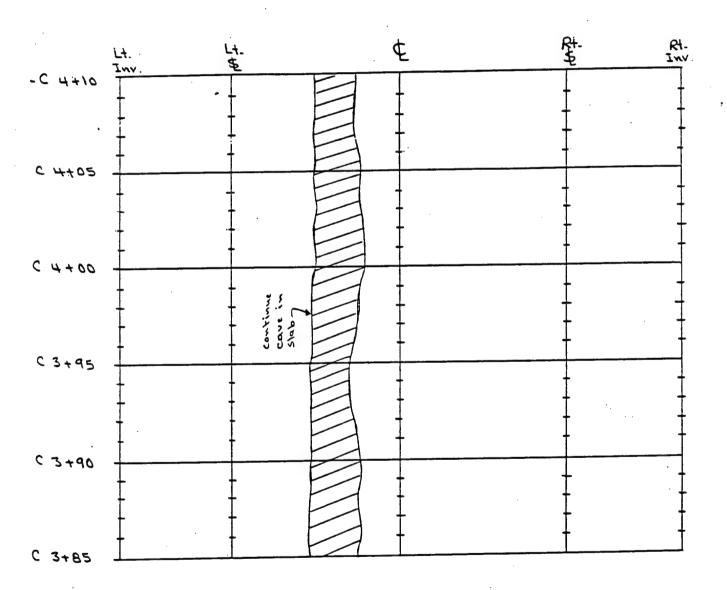


Massive Rock

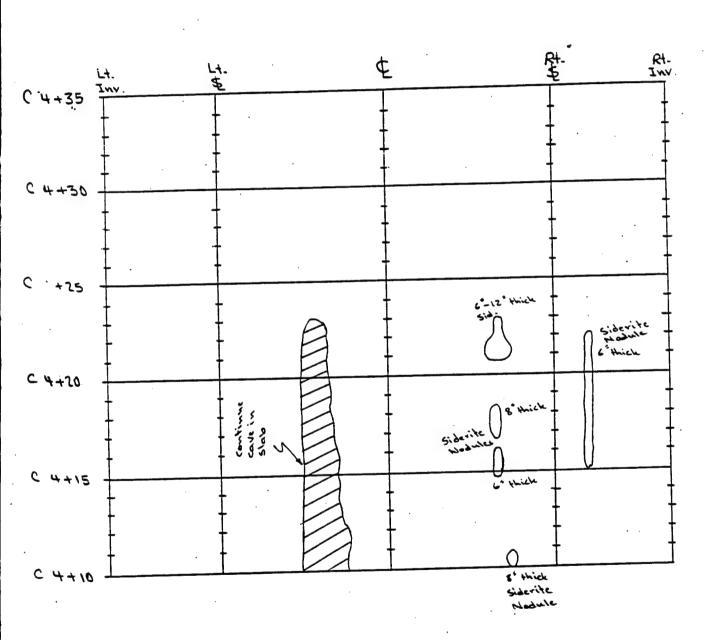
Subject Cal. Adj.	Project	UTP				Computed	Date
Siderille Siderille		cal. A	li‡	 		Checked	Date
10 Siderille Covering	Task			 ي		Sheet \5	01 21
+80	Ĺŧ.	٠	- - -	× 0 ×	Detached rock has a pyramid- shaped cross section with 6-18 height.	نز ۸	Rt- Inv.
75 - 10 - 10 - 10 - 10 - 10 - 10 - 10 - 1	103	Hick.		+	ڏن! دوني		
+TO	.	Sidevile	-	+	0.	-	
	+			+	Siderite)	- - - - -	
	+			+		† † †	
	-		:	+		+	† †

* This cave-in occured @ one time. Shotcrete liner was @ Sto. C3+75 and Face @ Sta. C4+27 when cave-in occured.

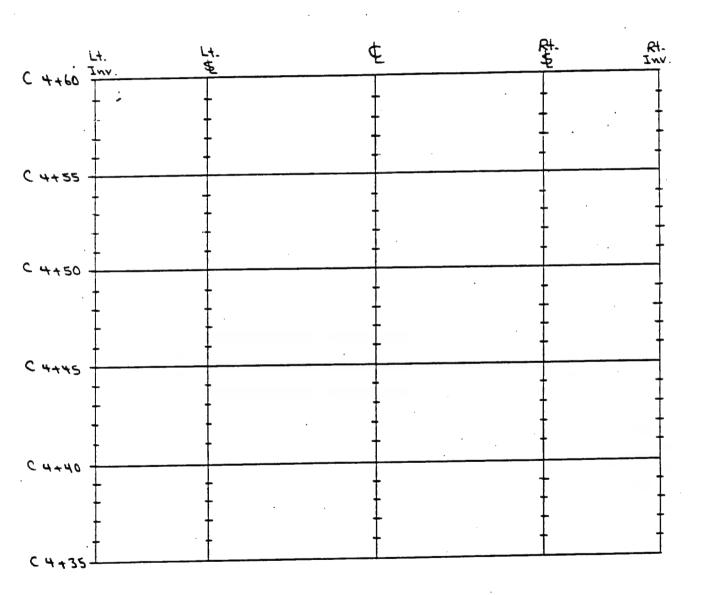
Project UTP	Computed	Date
Subject Cal Adit Geo. Mapping	Checked	Date
Task	Sheet \6	01 21



Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Tack	Sheet \7	01 21

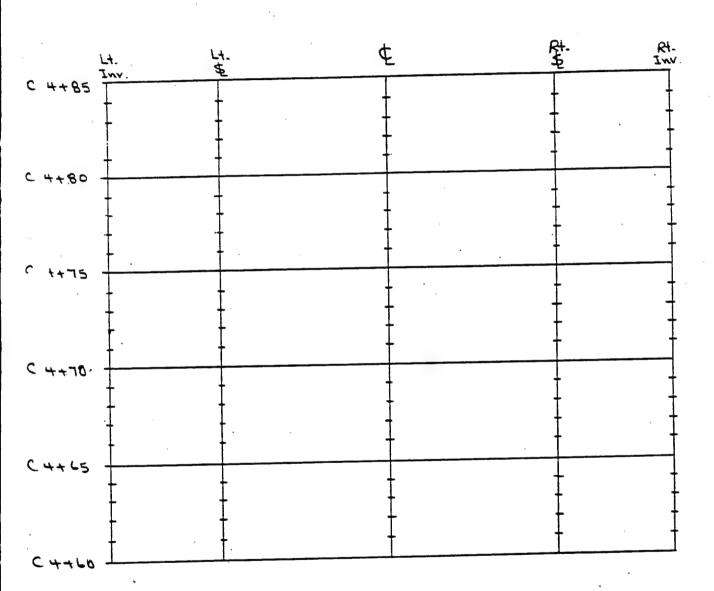


Project UTP	Computed	Date
Subject Cal. Adit	Checked	Date
Task	Sheet 18	Of Z1



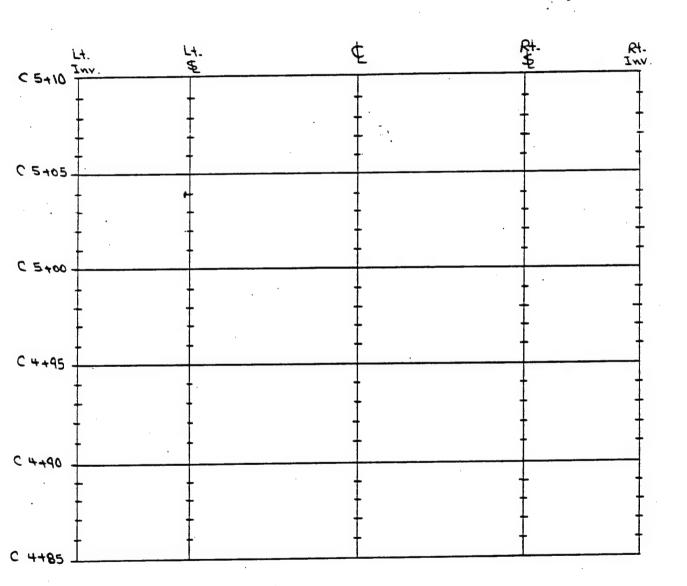
Massive Rock

Project UTP	Computed	Date
	Checked	Date
	Sheet \Q	or Z\



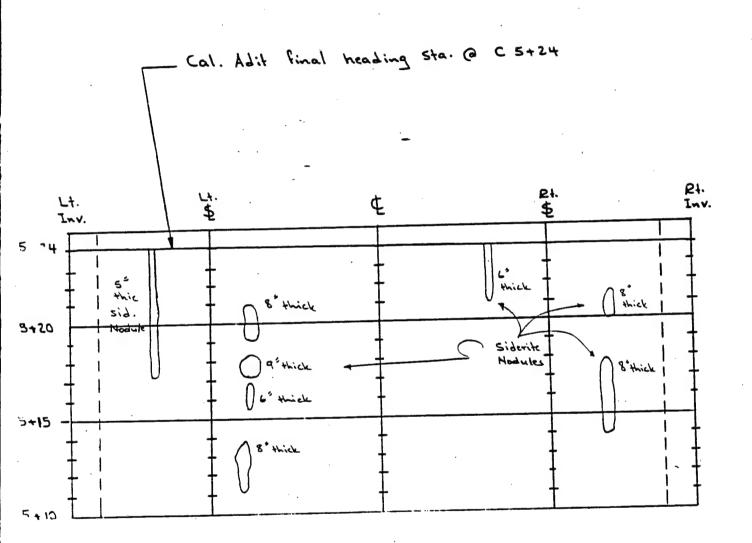
Massive Rock

Project	UTP		Computed	Date
Subject	Cal.	Adit	Checked	Date
Task			Sheet ZO	01 21



Massive Rock

Project	UTP	Computed	Date
Subject	Cal. Adit - Geological Mapping	Checked	Date
Took Rock		Sheet 21	0121



* Tunnel is wider by 3 from sta. (5+10 to C5+24

Appendix D
Photographs

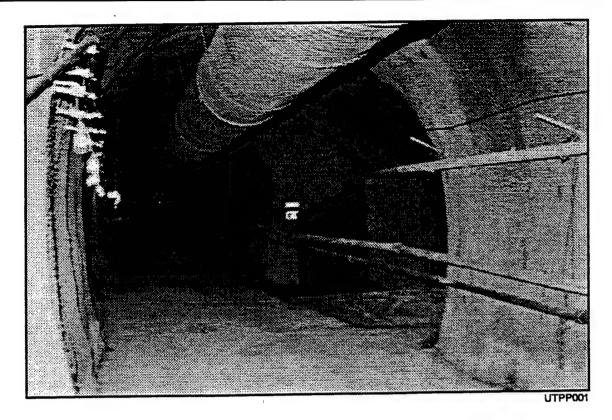


Figure D-1. Sump Bay.

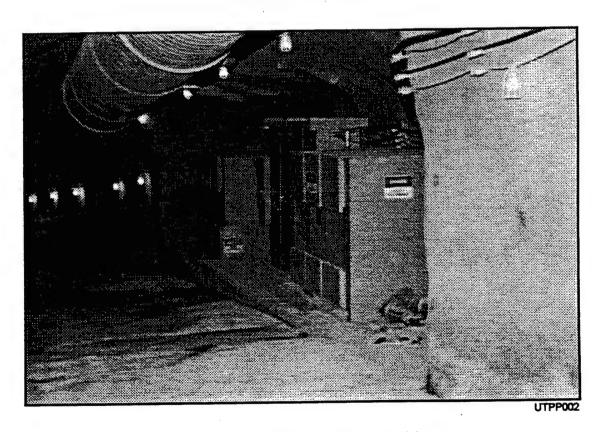


Figure D-2. Transformer bay (looking in).

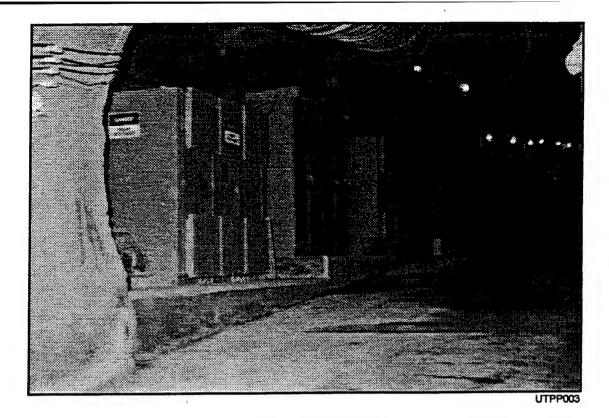


Figure D-3. Transformer Bay.

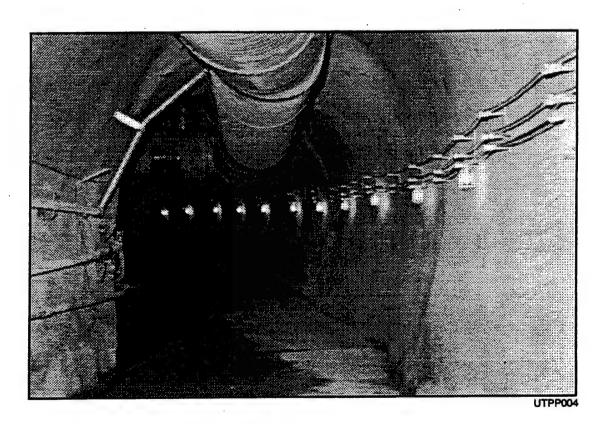


Figure D-4. Intersection ($Cal.\ Adit\ to\ Left$).

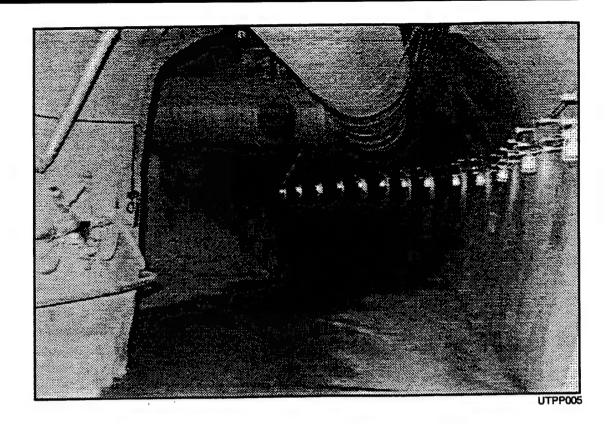


Figure D-5 Intersection (Cal. Adit to Left)

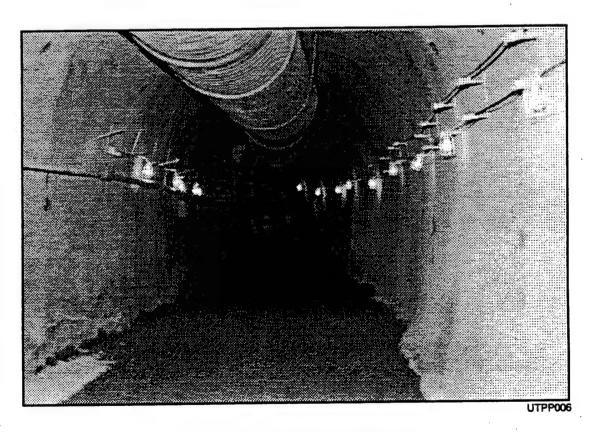


Figure D-6 Test Adit Looking Towards Plug

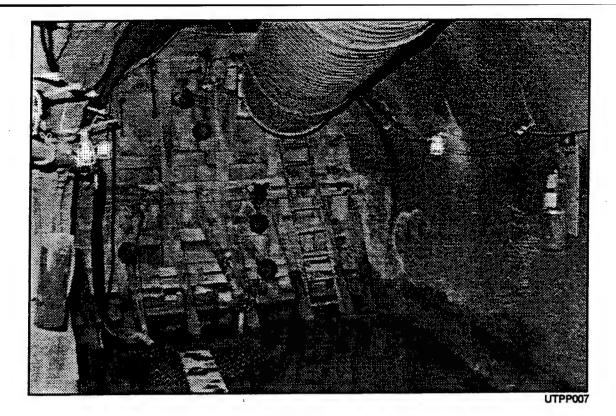


Figure D-7 Plug's Upper Face

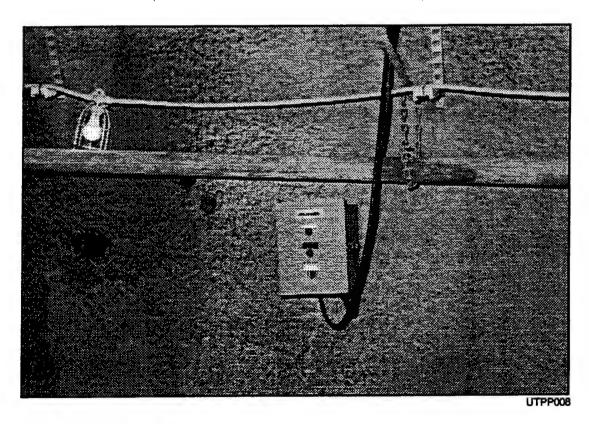


Figure D-8 Typical Electric Switch for Water Pump at Bulkhead

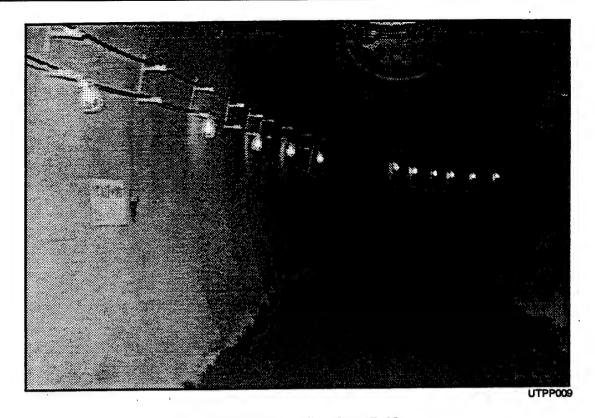


Figure D-9 Test Adit at Sta. 17+00

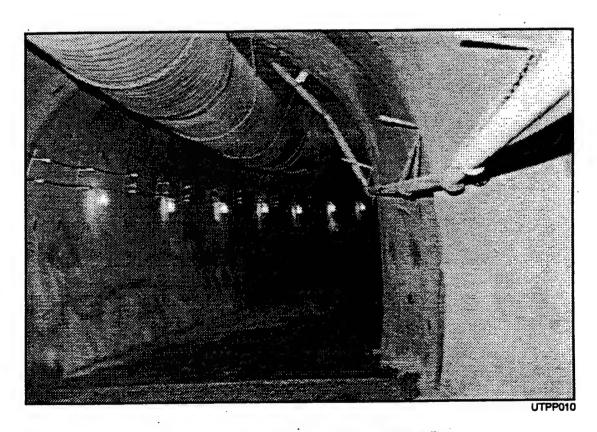


Figure D-10 Test Adit Intersection with Cal. Adit

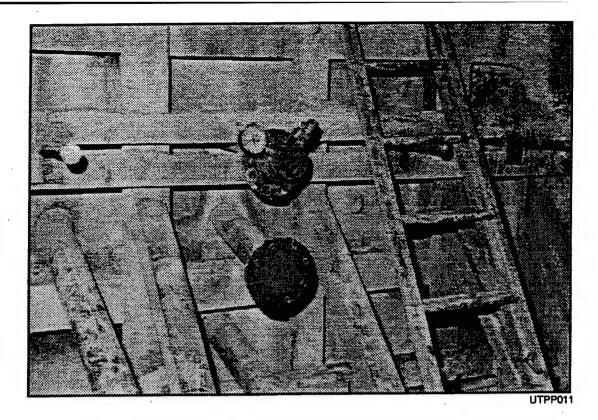


Figure D-11 Plug (Upper Bulkhead with Fill-Bleed Lines Shown)

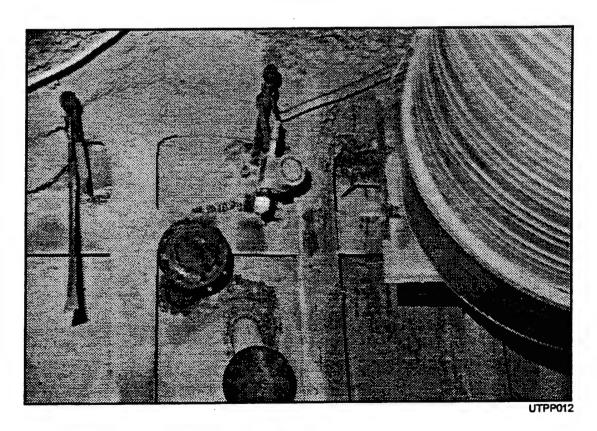


Figure D-12 Gas Monitor at Plug

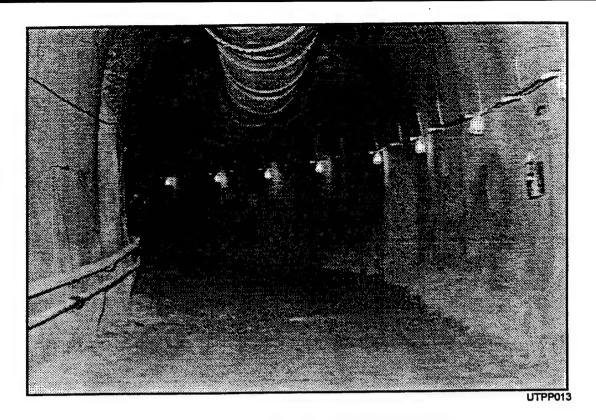


Figure D-13 Cal. Adit (Looking from Intersection)

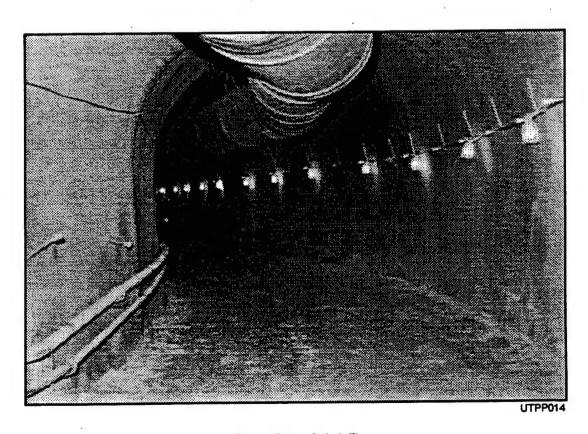


Figure D-14 Cal. Adit

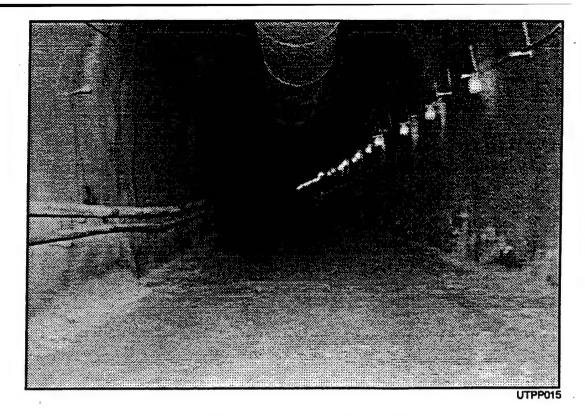


Figure D-15 Cal. Adit (Looking towards its Terminal Station)

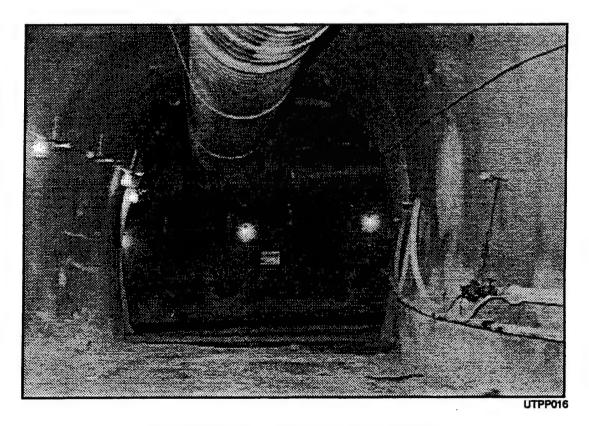


Figure D-16 Intersection (Looking from Cal. Adit)

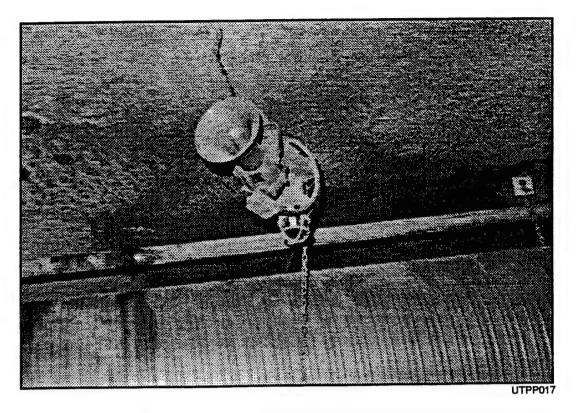


Figure D-17 Gas Warning/Monitor Siren and Light

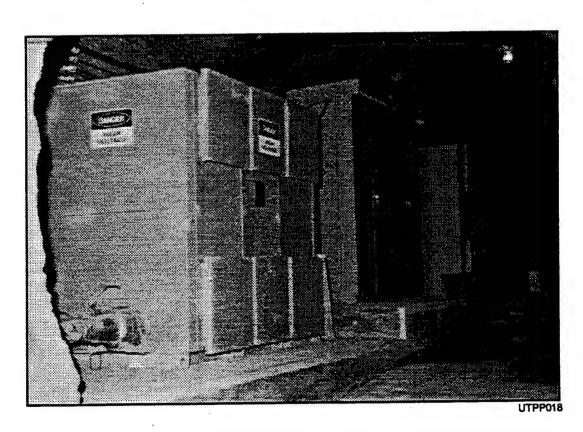


Figure D-18 Transfer Bay

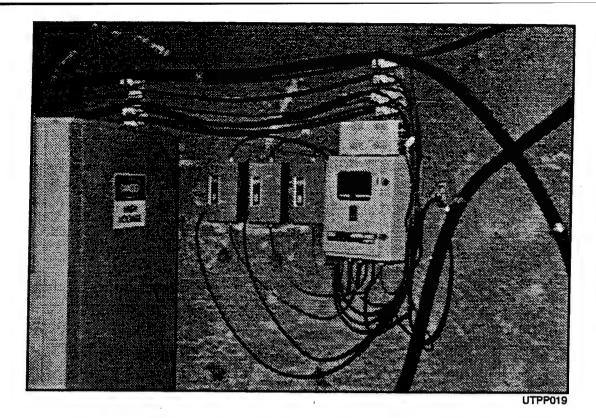
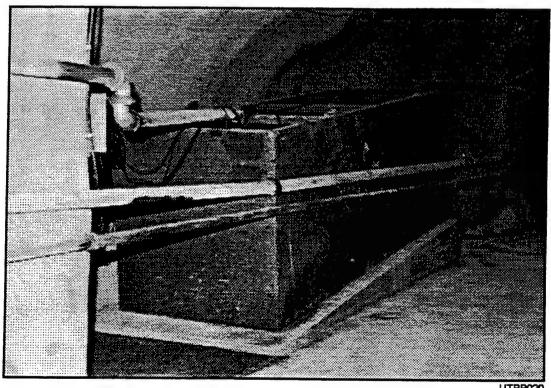


Figure D-19 Electric Controls and Gas Monitor Box



UTPP020

Figure D-20 Sump Tank at Sump Bay

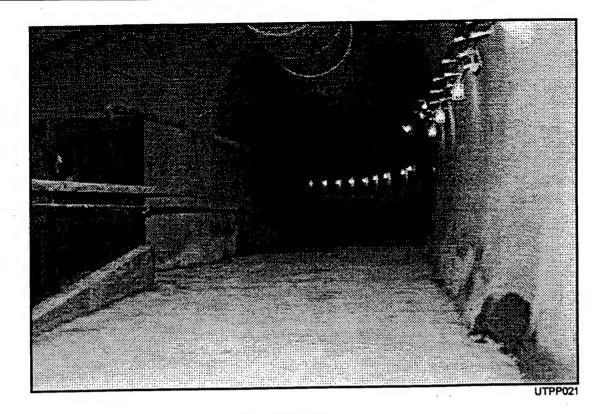


Figure D-21 Sump Bay

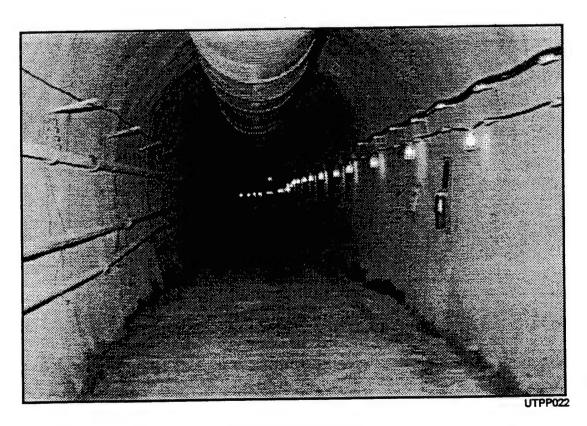


Figure D-22 Test Adit



Figure D-23 Access Road to Rodgers Hollow (Portal on Left)

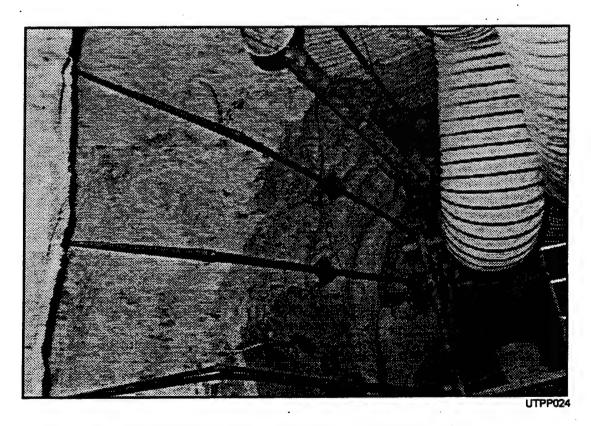


Figure D-24 Plug During Construction. Shown are Pressure Grout Pipes with Gas Checks (Plates) and 4" Dia. Bleed Lines

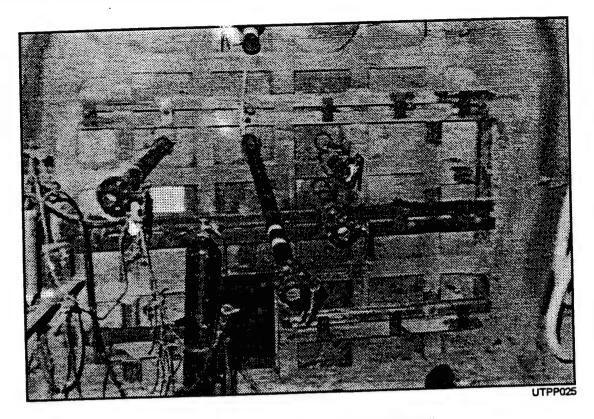


Figure D-25 Front (Upper) Bulkhead with Fill and Bleed Line Penetrations

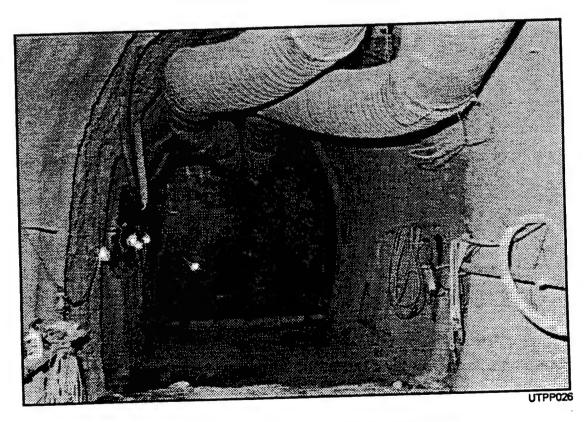


Figure D-26 Finished Rear (Lower) Bulkhead from Inside Plug

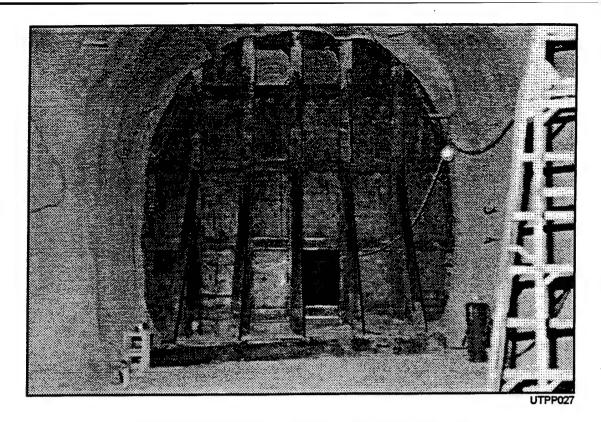


Figure D-27 Back of Lower Bulkhead Prior to completion. Shown are Supports and Access Opening

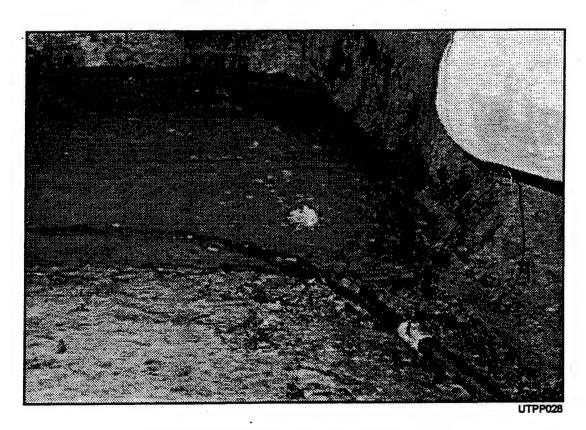


Figure D-28 Gas (Methane) Seepage at Sta. 18+50

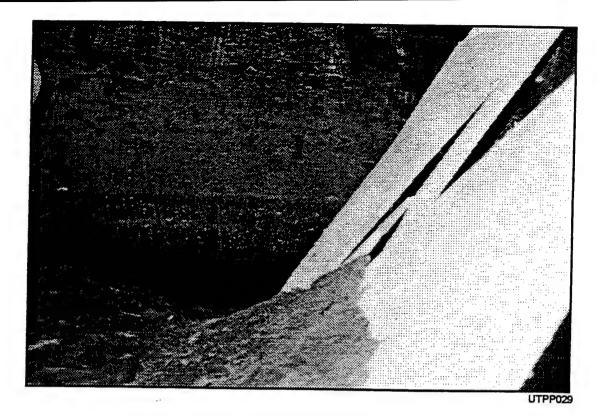


Figure D-29 Interface Bewteen New Providence Shale (Top) and New Albany Shale (Bottom) at Sta. 18+54

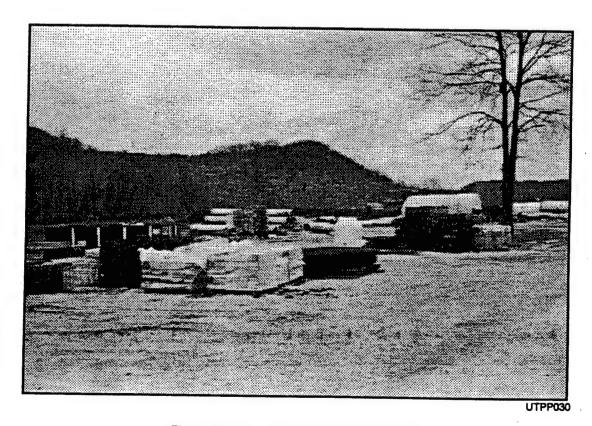
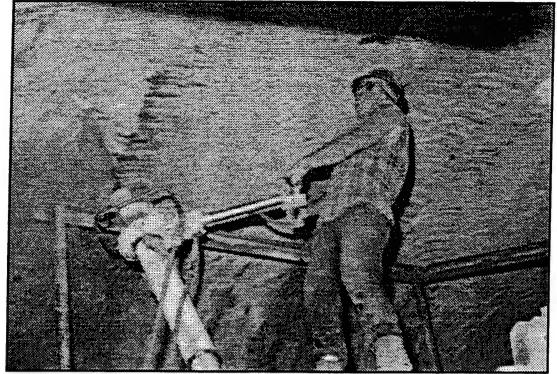
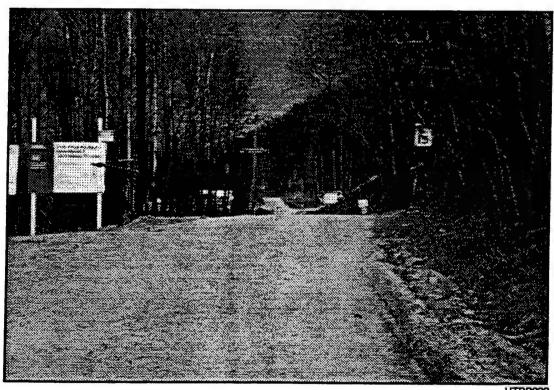


Figure D-30 Yard (Storage) Area on Site



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Figure D-31 Rock Bolt Installation



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Figure D-32 Access Road to Site (Portal on Right)

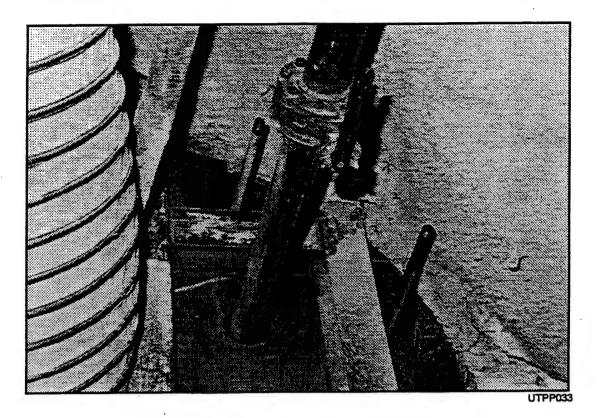


Figure D-33 Gas Bleed Line with Valve Penetrating Upper (Front) Bulkhead

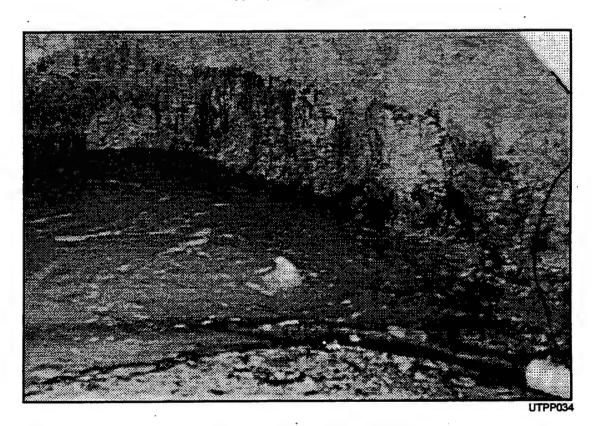


Figure D-34 Gas Seepage at Sta. 18+50



Figure D-35 Piezometer Monitoring Assembly P-1

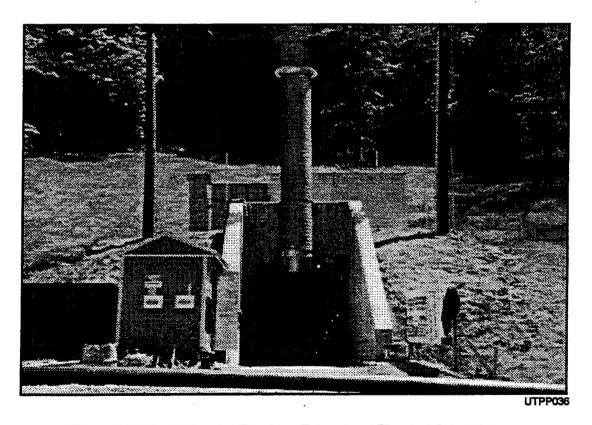


Figure D-36 Portal Showing Final Vent Exhaust and Electrical Substation on Top (Stack Removed Recently for Safety Reasons)

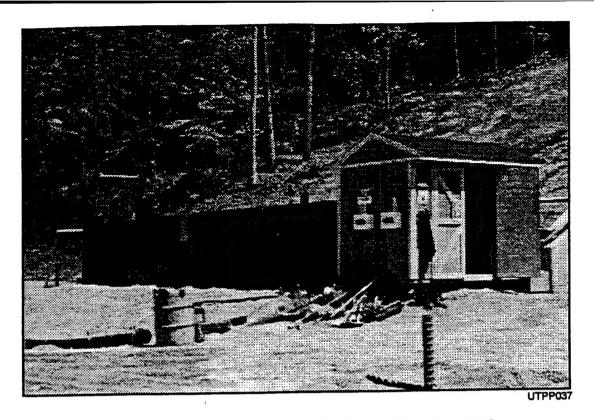
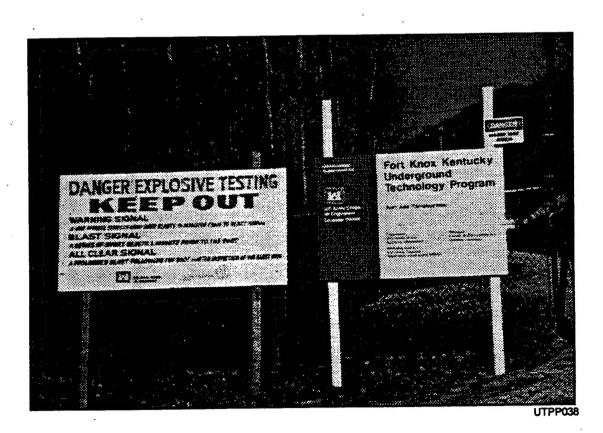


Figure D-37 Sump Tanks Outside Tunnel Delivering Water Pumped Out of Tunnel to Dewatering Line Going to Salt River



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